Vol. 83 NOVEMBER-DECEMBER 1956 No. 6

Bulletin

of the

Torrey Botanical Club

UNIV. OF MICHIGAN
FEB 28 1957
SCIENCE LIBRARY

CONTENTS

A New Species of Muellerella and Its Development. *John B. Routien* 403

Some Notes on the Influences of Various Buffer Salts upon the Rate of Mitosis in Root Tips of Trillium Sessile L. ..... *Paul C. Bailey* 410

New and Unidentified Species of Synchytrium, II. *John S. Karling* 415

Aseptic Studies on Metabolism of Nitrogenous Compounds in Plants. ..... *L. G. Nickell* 421

The Cytology of Xanthisma Texanum D. C. IV. Megasporogenesis and Embryo Sac Formation, Pollen Mitosis and Embryo Formation. *C. A. Berger, E. J. Feeley and E. R. Witkus* 428

Torreya

An Annotated Preliminary Catalogue of the Vascular Flora of Rockland County, New York. By J. Harry Lehr. Sporobolus Cryptandus (Torr.) A. Gray in the New Jersey Pine Barrens. By Jack McCormick and Murray F. Buell. Field Trip Reports. Book Reviews. Note. 435

Index to American Botanical Literature 443

Index to Volume 83. 457

Published for the Club bi-monthly
by
THE BUSINESS PRESS, INC.
N. QUEEN ST. AND McGOVERN AVE.
LANCASTER, PENNSYLVANIA

THE TORREY BOTANICAL CLUB

Officers for 1956

President: LELA V. BARTON

Vice-presidents:
EDWIN T. MOUL
DAVID D. KECK

Recording Secretary:
FRANK G. LIER

Corresponding Secretary:
ELEANOR R. WITKUS

Treasurer: GILY E. BARD

Editor: CHARLES A. BERGER

Business Manager:
REGINA M. DUFFY

Bibliographer: MRS. LAZELLA SCHWARTEN

The Bulletin of the Torrey Botanical Club

Editor

Charles A. Berger

Associate Editors

Irving W. Bailey
Stanley A. Cain
Adriance S. Foster
Barbara McClintock
Murray F. Buell
Edwin B. Matzke
Wendell H. Camp
Donald P. Rogers
H. W. Rickett
Frederick Kavanagh

John A. Small (Torreya)

Membership dues should be sent to Dr. Gily E. Bard, Hunter College New York 21, N. Y. Subscriptions and correspondence about advertisements and back numbers should be addressed to Dr. R. M. Duffy, Biology Department, Jersey City State Teachers College, Jersey City, New Jersey. Communications about exchanges should be sent to Dr. E. R. Witkus, Biological Laboratory, Fordham University, New York 58, N. Y. Manuscripts intended for the Bulletin should be sent to Dr. C. A. Berger, Biological Laboratory, Fordham University, New York 58, N. Y. Material for Torreya should be sent to Dr. John A. Small, Douglass College, New Brunswick, N. J.

Claims for missing numbers must be made within 60 days from the date of issue. Changes of address of members should be sent to the treasurer.

The subscription price of the Bulletin of the Torrey Botanical Club (including Torreya), is $9.00 a year except to active members of the Club. The annual membership dues covers a year's subscription to the Bulletin.

Entered as second-class matter October 8, 1940 at the post office at Lancaster, Pa., under the Act of March 3, 1879. Accepted for mailing at the special rate of postage provided for in the Act of February 28, 1925, embodied in Paragraph (d-2) Section 34.40 P. L. & R. of 1948.

BULLETIN OF THE TORREY BOTANICAL CLUB
VOL. 83, NO. 6, PP. 403–409 DECEMBER, 1956

A NEW SPECIES OF MUELLERELLA AND ITS DEVELOPMENT[1]

JOHN B. ROUTIEN

A sample of soil collected in August of 1954 was plated out on several media in November of that year and incubated at 28° C for three days. Examination of the cultures that developed revealed the presence of one on grass decoction agar[2] only that was different from any fungus known to the author.

Taxonomy. The fungus proved to be an Ascomycete with bitunicate asci produced in a pseudothecium. Using Munk's (1953) paper it was identified as a member of the genus *Muellerella* in the family Didymosphaeriaceae which Luttrell (1955) places in the new order Pleosporales. Comparison of this fungus with the description of species supplied by Saccardo (1882) and von Keissler (1930) showed that it was an undescribed species. The name *Muellerella nigra* is proposed for it.

Muellerella nigra sp. nov. Pseudothecia singulatim vel in gregibus exiguis disposita, parva, globosa vel subglobosa, atra; asci cylindraceo-clavati, breviter stipitati, 30–36 × 9.0–10.5 μ, plerumque 33 × 10 μ, 32-sporiferi; sporae ellipticae, leves, pallide olivaceo-brunneae, eguttulatae, 4–6.0 × 2.5–3.5 μ, plerumque ca. 5 × 3.

Mycelium flesh-gray, finally gray black to nearly black; pseudothecia occurring singly or in small groups, numerous when developing on potato-dextrose agar, globose to subglobose, from 230 × 230 μ to 535 × 470 μ when viewed from above, black, at first mostly immersed in the agar but finally mostly above the surface of the agar, finally opening irregularly to allow spores and asci to ooze out in a gray mass; asci cylindrical-clavate, tapering gradually to the base, with a short stalk, bitunicate, 30–36 × 9.0–10.5 μ, mostly 33 × 10 μ, 32-spored, croziers numerous; ascospores elliptical, smooth, pale olive-brown, non-guttulate, 4.0–6.0 × 2.5–3.5 μ, mostly about 5 × 3 μ.

Isolated from soil from Bondville, Kentucky.

Type specimen deposited at The New York Botanical Garden.

Cultures deposited at American Type Culture Collection and Centraalbureau voor Schimmelcultures as isolate 17M48.

Development of Pseudothecia. The fungus was planted on PDA and incubated at 28° C. Observations were made from time to time. Somewhere

[1] Illustrations published with the assistance of the Lucien M. Underwood Memorial Fund.

[2] Preparation of grass decoction agar was as follows: 50 gms. dried grass were autoclaved in one liter of distilled water for 30 min. at 15 lbs. pressure. The liquid was filtered through cheese cloth and 2 gms. K_2HPO_4 were added. The pH was adjusted to 6.2, distilled water was added to make one liter and 15 gms. of agar were added. Medium was autoclaved 20 min. at 20 lbs.

[THE BULLETIN for September–October, 1956 (83: 327–341) was issued October 17, 1956]

along a hypha, often near the tip (fig. 1) a spherical swelling develops that might be called a pseudothecial primordium. It appears to be cut off from

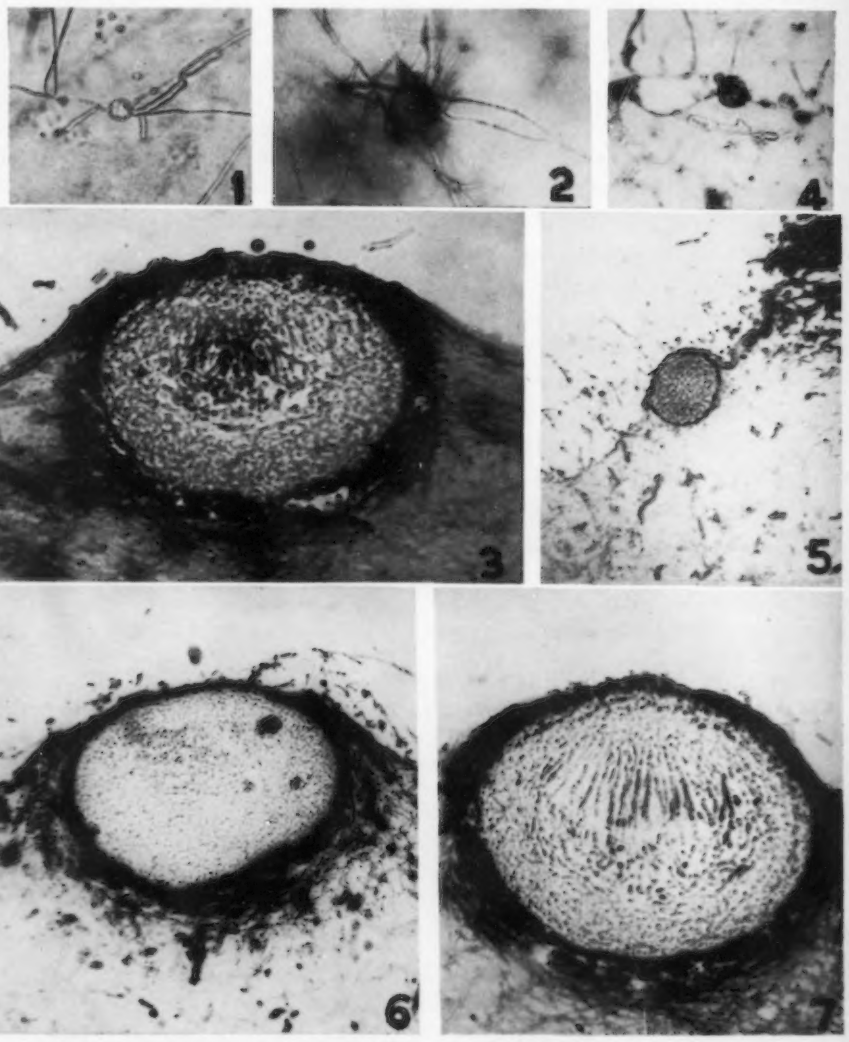


FIG. 1. Living pseudothecial primordium on the surface of agar. FIG. 2. Slightly older, living, young pseudothecium showing hyphae that develop from the surface. FIG. 3. Longitudinal median section of young pseudothecium showing pseudoparaphyses and wall partly composed of surrounding vegetative hyphae. FIG. 4. Longitudinal median section of very young pseudothecial primordium showing few cells inside. FIG. 5. Longitudinal median section of young pseudothecium before pseudoparaphyses form. FIG. 6. Longitudinal median section through youngest pseudothecium showing beginning of formation of pseudoparaphyses. FIG. 7. Longitudinal median section through pseudothecium showing complete development of pseudoparaphyses and basal layer of young asci.

adjoining cells by septa. Twenty-four hours later hyphae have formed that project outward in all directions (fig. 2). These presumably develop by regeneration of growth at different areas on the surface of the pseudothecial primordium. They continue to grow and branch. In the description of the development of *Pseudoplea Gauemannii*, Wehmeyer (1955) also observed the formation of short branches from the cells that were enlarging to become the ascocarp primordia; in this fungus these branches coiled about the main hypha but were not involved in the transfer of nuclei. In *M. nigra* they also were not functional in this manner, but they did become incorporated to some extent as a layer outside the pseudothecial wall. They and some of the vegetative hyphae around the pseudothecium became compressed by growth of the pseudothecium to form a thick wall that at least sometimes adhered to the true pseudothecial wall (fig. 3). In some cases the attachment of this layer to the pseudothecial wall is not so great; sections of the ascocarp show that the pseudothecial wall easily tears away from the external layer.

As the hyphae begin to develop outward from the surface of the pseudothecial primordium the interior of the body is seen to consist of a mass of small cells (fig. 4). How these develop was not determined.

At a slightly later stage in development the young pseudothecium is larger and has a pseudoparenchymatous tissue of more and larger cells (fig. 5) than in the earlier stage described. At this time the tissue is uniform in appearance.

A longitudinal section through a moderately young pseudothecium (fig. 6) reveals the presence of pseudoparaphyses that form near the top and grow downward. A well-developed pseudoparenchyma occupies the rest of the pseudothecium. A later stage (fig. 7) shows continued extension of the pseudoparaphyses.

The pseudoparaphyses develop into a branching system of downwardly-directed hyphae. No anastomoses were seen either in fixed and stained preparations or in tissue teased out of young pseudothecia. The hyphae consist of rather short cells measuring mostly 1.3–1.6 μ in width but sometimes 3 μ in width. The cells are uninucleate.

When the pseudoparaphyses reach a length equal to the final depth of the cavity of the pseudothecium they apparently form branches at 90° or less that grow approximately at right angles to the original pseudoparaphyses and form the base of the cavity. Shorter pseudoparaphyses form the sides.

Darkly staining cells that may be ascogenous cells can be found, but the manner of their formation was not seen. They did appear to form first in a basal hymenial layer and then, by prolific crozier development, to extend

the hymenial layer up and around the interior of the pseudothecium (fig. 8). At this stage the pseudoparaphyses have begun to disappear.

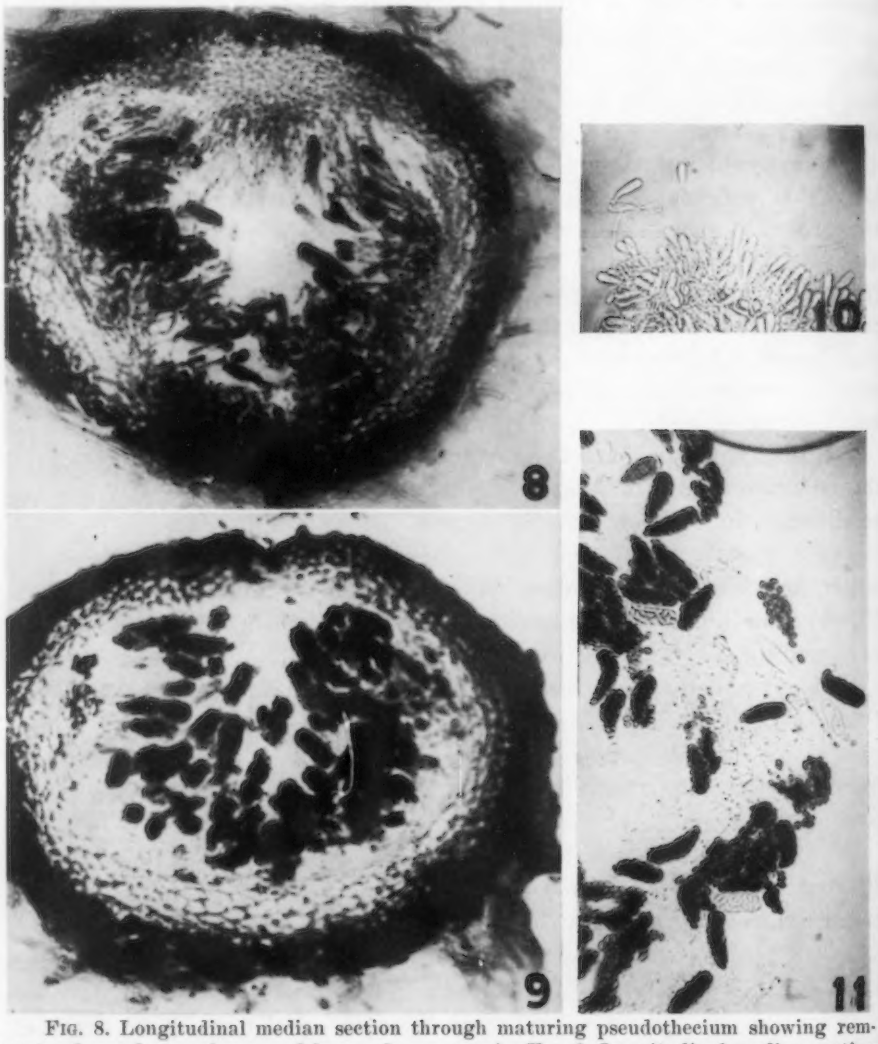


FIG. 8. Longitudinal median section through maturing pseudothecium showing remnants of pseudoparaphyses and layer of young asci. FIG. 9. Longitudinal median section through mature pseudothecium showing mass of mature asci. FIG. 10. Young, living, immature asci in water mount. FIG. 11. Mature, living asci, some of which have ruptured to allow endoasci to discharge.

When development is completed the thirty-two-spored asci occupy all of the space inside of the pseudothecium except for a layer of tissue lining the wall (fig. 9).

The pseudothecia do not open until the culture is at least two weeks

old. A mass of gray tissue composed of unopened asci, open asci, spores and croziers can be found. The opening is very often a split lengthwise of the pseudothecium; otherwise it is irregular in shape.

The Ascus. The asci seem to attain nearly their full size before spore formation begins (fig. 10). Then suddenly thirty-two spores can be found in each ascus (fig. 11).

When the mature asci are placed in a drop of water almost no change in size of the ascus takes place. Almost immediately, however, spores will begin to discharge. With two or three turning and twisting movements of the ascus the tip breaks off cleanly circumferentially. The spores are discharged still in a mass and surrounded by the inner, hyaline ascus wall (fig. 11). The tip of the ascus often is carried along on the end of the mass of spores.

To date I have not seen any forcible discharge of the spores from inside the extruded endoascus, though several efforts were made using the methods described by Hodgetts, (197), Brierly (1913), Ingold (1933) and Luttrell (1951b). It is possible that the method of opening of the ascus described here may be an abnormality because water mounts were used; this possibility was pointed out for other fungi by Hodgetts, Cain and Butler according to Luttrell (1951a), though several workers, again according to Luttrell (1951a,) though several workers, again according to Luttrell (1951a), have reported seeing this type of dehiscence. However, because the asci of this *Muellerella* have not opened except in water the observations reported do not seem to be abnormalities.

Prolonged immersion of the endoascus in water results in extensive swelling of the gelatinous wall.

Spore Germination. Suspensions of asci and of ascospores were streaked onto the surface of potato-dextrose agar, Czapek-Dox agar, Wickerman's medium for cultivation of yeast and the 0.7% sodium acetate agar used by Olive (1956) and incubated at 28° C. Suspensions of asci and ascospores in sterile water were also incubated. Neither the spores in the endoascus nor the separate, freed ascospores germinated after three days of incubation; further incubation was not possible because mycelial fragments had begun to grow.

Discussion. Species of *Muellerella* have been reported from several European countries by von Keissler (1930), but in the Western Hemisphere they are known only from Peru, Mexico and Labrador.[3] The present finding, therefore, is the first case of a species of *Muellerella* being found in the U. S.

[3] Dr. I. Mackenzie Lamb, in a personal communication, cited *M. polyspora* Hepp var. *hospitans* (Stitz) Keissl. from Peru as reported by Karl von Keissler in Beih. Bot. Centralbl. **50**: 383, 1933. *M. lopadii* Vouaux was reported from Mexico (Bull. Soc. Myc. Fr. **29**: 42, 1913). Dr. Rolf Santesson, by letter, contributed the information that *M. thallophila* Arn., a synonym *of M. haplospora* (Th. Fr.) Arn., was reported from Labrador by F. Arnold in a paper entitled "Labrador" that was published in München in 1896.

This also is the first time that a species of *Muellerella* has been isolated from soil. Whether it lives there normally or whether it was present temporarily in the form of a spore is, of course, unknown.

The fact that other species of this genus have always been found on lichens, presumably as parasites, raises several questions. Can these other species be cultivated on artificial media? Insofar as the author can determine, from the literature, no one has tried. Is this newly described species peculiar in being an inhabitant of the soil, or should it be found on some lichen? The writer hopes to have more information about these questions at a later date.

That the asci of *Muellerella* are bitunicate and that the fruiting body has pseudoparaphyses is clear from Munk's (1953) discussion of the family Didymosphaeriaceae in which he placed this genus. Regarding the pseudoparaphyses he says "The cells of the interascicular tissue are paraphysoid, very thin, often branched and anastomosing." The present paper provides illustrations of the development of the fruiting body and its contents.

The origin of the ascostroma from a single, spherical cell is similar to that described by Müller (1951) in *Pleospora Gaeumannii* and by Wehmeyer (1955) in *Pseudoplea* (*Pleospora*) *Gaeumannii*. In this fungus the protoplasts of certain larger, swollen cells, according to Wehmeyer (1955), "divide by cleavage into a number of endogenous protoplasts." Figures 2 and 17 in Wehmeyer's (1955) paper are similar to figure 4 shown here, as is figure 2, d in Müller's (1951) paper. Whether the initial stages in formation of the ascostroma in *M. nigra* are exactly the same as in *P. Gaeumannii* could not be determined, but it may well be that they are quite similar. The cells of the pseudothecial wall in *M. nigra* may have developed from the cells showing the retrogressive tendency described by Wehmeyer (1955).

No structures like ascogonia, trichogynes or antheridia were seen, and there was no evidence of an ostiole. The ascostroma apparently opens irregularly at the apex due to pressure developed by the cells within.

SUMMARY

1. A new fungus, named *Muellerella nigra*, and isolated from a soil sample, is described.

2. The ascostroma develops initially from a single, swollen cell of a hypha.

3. Pseudoparaphyses delimit the ascigerous area. Asci are produced on the base and sides of this layer and point toward the center of the centrum.

4. Bitunicate asci with thirty-two ascospores in each are produced. The ascostroma is ruptured irregularly at the apex to release the contents.

Acknowledgements. The author is indebted to several individuals for assistance. He is grateful for the technical help of Irene Rollman and Susan Carey Canham, for the preparation of the slides by Sam P. Meyers and for

the photography by Joseph Sardinas. Sincere thanks also are expressed to Dr. Donald P. Rogers for preparation of the Latin description.

BIOCHEMICAL RESEARCH DEPARTMENT, CHAS. PFIZER AND CO., INC.
BROOKLYN 6, NEW YORK

Literature Cited

Brierly, W. B. 1913. The structure and life-history of *Leptosphaeria lemaneae*. Mem. Proceed. Manchester Lit. Phil. Soc. **57**: 1–25.

Hodgetts, W. J. 1917. On the forcible discharge of spores of *Leptosphaeria acuta*. New Phytol. **16**: 139–146.

Ingold, C. T. Spore discharge in the Ascomycetes. I. Pyrenomycetes. New Phytol. **32**: 175–196.

Keissler, Karl von. 1930. Die Flechten-parasiten. In L. Rabenhorst, Kryptogamen Flora. **8**: 1–712.

Luttrell, E. S. 1951a. Taxonomy of the Pyrenomycetes. The University of Missouri Studies **24**: 1–120.

———— 1951b. The morphology of *Dothidea collecta*. Am. Jour. Bot. **38**: 460–471.

———— 1955. The ascostromatic Ascomycetes. Mycologia **47**: 511–532.

Müller, E. 1951. Über die Entwicklung von *Pleospora Gaeumanii* nov. spec. Ber. Schweiz. Bot. Ges. **61**: 165–174.

Munk, A. 1953. The system of the Pyrenomycetes. Dansk. Bot. Ark. **15**: 7–163.

Olive, L. S. 1956. Genetics of *Sordaria fimicola*. I. Ascospore color mutants. Am. Jour. Bot. **43**: 97–106.

Saccardo, P. A. 1882–1926. Sylloge fungorum. Vols. 9, 17, 22, 24.

Wehmeyer, L. E. 1955. The development of the ascocarp in *Pseudoplea gaeumannii*. Mycologia **47**: 163–176.

BULLETIN OF THE TORREY BOTANICAL CLUB
VOL. 83, No. 6, pp. 410–414 DECEMBER, 1956

SOME NOTES ON THE INFLUENCES OF VARIOUS BUFFER SALTS UPON THE RATE OF MITOSIS IN ROOT TIPS OF TRILLIUM SESSILE L.[1]

PAUL C. BAILEY

Bailey (unpublished) has indicated that hydrogen-ion concentration exerts a considerable influence upon the rate of mitosis as well as upon the mitotic figures within root tips of *T. sessile L.* He has also shown that the same hydrogen-ion concentrations, when adjusted with the different agents, show different influences. These studies of pH influences were made with the hydrogen-ion concentrations being adjusted with hydrochloric acid and sodium hydroxide, as well as with two buffering solutions. Since a particular hydrogen-ion concentration will show entirely different effects when adjusted with these different agents, it seems reasonable to assume that the difference in effect is a chemical one rather than an actual pH effect. It is the purpose of this study to determine the effects of various buffer salts upon the rate of mitosis and upon the mitotic figures within root tips of *T. sessile* L.

Materials and methods. Rhizomes of *T. sessile* L. were potted in peat moss so as to provide a source of fresh growing root tips. After roots had appeared, the rhizomes were rinsed in distilled water, wrapped in wet paper towels to prevent excessive drying, and suspended over a culture dish containing 500 ml. of distilled water to which had been added various concentrations of boric acid, potassium acid phthalate, and potassium dihydrogen phosphate. Exposures to these various concentrations of buffer salts were made for periods of time ranging from 12 hours to 96 hours. All exposures were made at a temperature of 24° C (Bailey 1954). Slides for study were prepared using the Feulgen technique, together with a squash method.

Observations and discussion. Table 1 shows the influences of various concentrations of boric acid upon the rate of mitosis in root tips of *T. sessile* L. Exposure to these various concentrations was for periods of time ranging from 12 to 96 hours. Concentrations of boric acid greater than .2M produces apparent death to the exposed root tips within a 12 hour period. This is evidenced by the fact that root tips exposed to his concentration appear to be somewhat bleached and soft after the exposure period.

Table 1 shows that a concentration of .2M boric acid for 12 hours reduces the percentage of dividing nuclei within root tips of *T. sessile* L. to 2.8%.

[1] This investigation was supported by Research Grant No. C-2418 from the National Cancer Institute, Public Health Service.

This is approximately ½ the total percentage of dividing nuclei found in root tips exposed to distilled water for this period of time (Bailey, unpublished). After 12 hours exposure to .2M boric acid, 66.1% of the dividing nuclei were in prophase; 12.6% of these dividing nuclei were in metaphase, whereas 5.2% were in anaphase and 15.6% in telophase. These figures indicate a mild metaphase block after the root tips had been exposed to this concentration of boric acid for 12 hours. Perhaps the decrease in the percentage of anaphases is also significant. Root tips of *T. sessile* L. fail to survive when exposed to a concentration of .2M boric acid for periods of time longer than 12 hours.

TABLE 1. *Summary of H_3BO_3 influences upon rate of mitosis in root tips of T. sessile L.*

Concentration of H_3BO_3	Hours Exposure	Total % Dividing Nuclei	% Nuclei in Prophase	% Nuclei in Metaphase	% Nuclei in Anaphase	% Nuclei in Telophase
.4M	12	Mitotic figures difficult to distinguish.				
.2M	12	2.8	66.1	12.6	5.2	15.6
.1M	12	3.5	72.6	10.0	6.0	11.4
.1M	24	2.5	82.8	7.7	4.0	3.4
.1M	48	2.6	89.6	6.0	2.2	2.2
.1M	72	1.2	97.0	2.4	.0	.6
.1M	96	Mitotic figures difficult to distinguish.				
.05M	12	5.1	78.2	5.0	7.8	9.0
.05M	24	2.5	90.2	5.2	2.0	2.6
.05M	48	1.6	85.1	8.2	4.3	2.3
.05M	72	.03	90.0	10.0	.0	.0
.05M	96	0.0	Nuclei shrunken and vacuolate.			

Root tips exposed to a concentration of .1M boric acid for 12 hours show 3.5% of their nuclei to be in some stage of mitosis. The total percentage of dividing nuclei decreases to 1.2% after 72 hours exposure at this concentration, and after 96 hours exposure the mitotic figures become difficult to distinguish and the tips are apparently dead. It is very significant to note that at this concentration of boric acid 72.6% of the dividing nuclei are in prophase after 12 hours exposure, and continued exposure to this concentration of boric acid results in 97.0% of the dividing nuclei being in some stage of prophase. Table 1 also shows 10.0% of the dividing nuclei to be in metaphase after 12 hours exposure to this concentration of boric acid. The percentage of metaphase is reduced to 2.4% after 72 hours exposure. Table 1 further shows that the percentages of anaphases and telophases are reduced very significantly upon continued exposure to this concentration of boric acid. These figures indicate an almost complete blocking of mitosis at late prophase when tips are exposed to .1M boric acid for 72 hours.

Table 1 shows 5.1% of the nuclei to be in some stage of mitosis after exposure to a concentration of .05M boric acid for 12 hours. Again, the total

percentage of dividing nuclei decreases to a point where only .03% of the nuclei are in mitosis after 72 hours exposure to this concentration of boric acid. 5.0% of the dividing nuclei are in metaphase after exposure to this concentration of boric acid for 12 hours. The percentage of metaphases at this concentration increases to 10.0% after 72 hours exposure. It is also significant to note that the percentage of anaphases and telophases is somewhat reduced after exposure to .05M boric acid for 12 hours and that upon continued exposure to this concentration the percentage of anaphases and telophases is reduced to zero. These figures further indicate a total blocking of mitosis by boric acid. Concentrations of .0025M boric acid show that the same general pattern of effects but to a lesser degree. A further reduction in the concentration of boric acid fails to show any appreciable effects upon the rate of mitosis in root tips of *T. sessile* L.

TABLE 2. *Summary of KH_2PO_4 influences upon rate of mitosis in root tips of T. sessile L.*

Concentration of KH_2PO_4	Hours Exposure	Total % Dividing Nuclei	% Nuclei in Prophase	% Nuclei in Metaphase	% Nuclei in Anaphase	% Nuclei in Telophase
.2M	12	Difficult to distinguish mitotic figures.				
.1M	12	3.9	65.1	12.0	11.2	11.6
.1M	24	4.0	44.4	40.0	10.1	5.5
.1M	48	4.0	36.8	50.0	8.9	4.3
.1M	72	Difficult to distinguish mitotic figures.				
.05M	12	3.7	75.5	4.1	13.0	7.1
.05M	24	2.9	57.3	19.9	12.1	10.6
.05M	48	1.4	61.1	23.9	8.1	6.9
.05M	72	.06	57.3	28.0	9.8	4.9
.05M	96	Very few mitotic figures; difficult to distinguish.				

Table 2 shows the influences of potassium dihydrogen phosphate upon the rate of mitosis in root tips of *T. sessile* L. A concentration of .2M potassium dihydrogen phosphate produces death to the root tips after 12 hours exposure. Root tips of *T. sessile* L. show 3.9% of their nuclei to be in some stage of mitosis after exposure to a .1M concentration of potassium dihydrogen phosphate for 12 hours. This percentage of dividing nuclei remains about the same in root tips exposed to this concentration for periods of 24 hours and 48 hours. It is significant to note that 12.0% of the dividing nuclei are in metaphase after 12 hours exposure to a .1M concentration of potassium dihydrogen phosphate and that continued exposure increases the percentage of metaphases so that after 48 hours exposure at this concentration 50.0% of the dividing nuclei are in metaphase. It is further significant that the percentage of prophases decreases to 36.8% after 48 hours exposure at this concentration, and also there is a slight decrease in the percentage of anaphases with a somewhat greater decrease in the percentage of telophases. Root tips fail to survive exposure to a .1M concentration of potassium dihydrogen phosphate for periods of time as long as 72 hours.

After root tips have been exposed to .05M potassium dihydrogen phosphate for 12 hours 3.7% of the nuclei are in some stage of mitosis. This percentage of dividing nuclei decreases so that after 72 hours exposure only .06% of the nuclei are in some stage of mitosis. This concentration of potassium dihydrogen phosphate shows the same general pattern with respect to the percentage of the various stages of mitosis as did a concentration of .1M potassium dihydrogen phosphate, that is, upon continued exposure there was an increase in the percentage of metaphases with a corresponding decrease in the percentage of prophases, anaphases, and telophases. Table 2 shows that after 72 hours exposure to this concentration of potassium dihydrogen phosphate 28.0% of the dividing nuclei were in metaphase, whereas 57.3% are in prophase, 9.8% in anaphase and 4.9% in telophase. Root tips fail to survive exposure to .05M potassium dihydrogen phosphate for periods as long as 96 hours. A further reduction in the concentration of potassium dihydrogen phosphate shows a milder metaphase block with a final disappearance of any influences upon the rate of mitosis in root tips of *T. sessile L.*

TABLE 3. *Summary of KH phthalate influences upon rate of mitosis in root tips of T. sessile L.*

Concentration of KH Phthalate	Hours Exposure	Total % Dividing Nuclei	% Nuclei in Prophase	% Nuclei in Metaphase	% Nuclei in Anaphase	% Nuclei in Telophase
.025M	12	Difficult to distinguish mitotic figures.				
.012M	12	2.2	64.8	17.7	7.1	10.3
.006M	12	2.0	63.5	20.0	5.4	11.2
.003M	12	3.0	50.6	12.2	18.0	19.1
.0015M	12	.00	Normal resting nuclei.			
.00075M	12	.06	73.3	12.3	18.3	6.1

Table 3 shows the influences of various concentrations of potassium acid phthalate upon the rate of mitosis in root tips of *T. sessile* L. when exposed to these concentrations for periods of 12 hours. Concentrations of potassium acid phthalate greater than .012M result in the death of exposed root tips, whereas a concentration of .012M for 12 hours shows 2.2% of the nuclei to be in some stage of mitosis; 64.8% of these dividing nuclei are in prophase, 17.7% in metaphase, 7.1% in anaphase, and 10.3% in telophase. The same general pattern of dividing nuclei is seen at a concentration of .006M potassium acid phthalate. However, a concentration of .003M potassium acid phthalate shows a total of 3.0% of the nuclei to be in some stage of mitosis with 50.6% of these nuclei in prophase, 12.2% in metaphase, 18.0% in anaphase and 19.1% in telophase. No dividing nuclei were evident when root tips were exposed to a concentration of .0015M potassium acid phthalate for 12 hours. At a concentration of .00075M, .06% of the nuclei were observed to be in some stage of mitosis.

The figures given in Table 3 for the various concentrations of potassium acid phthalate would seem to indicate the presence of an inhibiting mechanism at metaphase between concentrations of .012M and .003M. Further observations show that a concentration of .0015M potassium acid phthalate probably allows the dividing nucleus to complete its division processes but causes an inhibiting of the interphase nuclei toward entering into prophase of mitosis.

Aside from the influences noted above upon the rate of mitosis within rot tips of *T. sessile* L., the buffer salts used in this study produced some additional effects. Boric acid produced an excessive chromosome contraction at late prophase and metaphase when root tips were exposed to concentrations of .1M and .05M. Potassium dihydrogen phosphate fails to produce an excessive chromosome contraction. However, at a concentration of .05M for 72 hours the metaphase chromosomes were observed to be clumped into one mass of chromatin material. Concentrations of potassium acid phthalate greater than .025M produce a clumping of the metaphase chromosomes, as well as a vacuolate condition within the interphase nuclei and the presence of distinct telophase bridges. Concentrations of potassium acid phthalate less than .012M show the mitotic figures themselves to be normal.

SUMMARY

1. A significant block of mitosis at late prophase occurs within root tips of *T. sessile* L. when exposed to concentrations of .1M and .05M boric acid for periods of time up to 96 hours. Continued exposure to these concentrations of boric acid also results in a decrease in the total number of dividing nuclei.

2. A concentration of .1M potassium dihydrogen phosphate produces a significant metaphase block within root tips of *T. sessile* L. when exposed for 24 and 48 hours. A concentration of .05M potassium dihydrogen phosphate produces a milder block after 24, 48, and 72 hours. A concentration of .05M potassium dihydrogen phosphate causes a marked decrease in the total percentage of dividing nuclei.

3. Concentrations of .012M–.003M potassium acid phthalate produce a mild metaphase block within root tips of T. sessile L. after exposure for 12 hours. Concentrations of .0015M and .00075M potassium acid phthalate slow down the processes of mitosis to a point where almost no dividing nuclei are seen after 12 hours.

BIOLOGY DEPARTMENT, ALABAMA COLLEGE
MONTEVALLO, ALABAMA

Literature Cited

Bailey, P. C., 1954. Temperature effects upon the rate of nuclear division in root tips of *Trillium sessile* L. Bull. Torrey Club. **81**: 414–421.

BULLETIN OF THE TORREY BOTANICAL CLUB
VOL. 83, NO. 6, PP. 415–420 DECEMBER, 1956

NEW AND UNIDENTIFIED SPECIES OF SYNCHYTRIUM, II.

JOHN S. KARLING[1]

In previous publications (1955a-c; 1956a-d) I described several new and unidentified species of *Synchytrium* which were found in various herbaria in this country and abroad. Most of these species occur on unrecorded hosts and because their full life cycles could not be determined from the herbarium material available they were not given specific names. Nevertheless, they were described with the purpose of calling attention to their occurrence and distribution and providing future collectors with data for comparisons. Probably, some of them will prove to be identical to known and identified species.

The present contribution concerns two new and two unidentified species which were collected by J. P. Tracy and H. E. Parks on *Ranunculus* and *Trifolium* in Humboldt Co., California. The herbarium material on which this study is based is deposited in the herbarium of the University of California at Berkeley, and I am very grateful to Drs. H. L. Mason and Lee Bonar for the loan of these specimens. Heavily infected portions of the host were thoroughly soaked in water, fixed in killing solutions in a vacuum to remove air, embedded in paraffin, sectioned at 7μ, and stained. Obviously, the host tissue in such sections was badly shrunken, but the fungi and galls were sufficiently well preserved to determine their characteristics.

S. variabilum sp. nov. Prosoris subsphaericis et ovalibus, 80–95 × 102–115μ; soris ovalibus, 106–120 × 128–148μ; sporangis polyhedris, 36–55μ; sporis perdurantibus sphaericis, 28–108μ, ovalibus, 26–40 × 65–98μ, oblongatis, 24–30 × 60–90μ, plano-convex, 78–96 × 130–180μ, parietibus levibus, 2.5–4.6μ crassis; germinatone ignoto.

Specimen typicum in herb. Univ. Calif., Berkeley, conservatum nos. 527090, 28868.

Prosori subspherical to ovoid, 80–95 × 102–115μ, with a light-amber wall, 1.8–2μ thick, lying in base of host cell when empty. Sori ovoid, 106–120 × 128–148μ; plug between empty prosorus and sorus 8–12 × 15–18μ. Sporangia 30–70 per sorus, polyhedral, 36–55μ in greatest diam., small ones 21–26μ, with a thin hyaline wall and yellowish-orange content. Zoospores unknown. Resting spores usually solitary and partly filling host cell, sometimes 2 in a cell, spherical, 28–108μ, ovoid, 26–40 × 65–98μ, oblong 24–30 × 60–90μ, or plano-convex, 78–96 × 130–180μ, with a smooth amber wall, 2.5–4.6μ thick; enveloped by a compact layer of reddish-brown residue which fills remainder of host cell; germination unknown.

Compositely dihomeogallic, or diheterogallic, galls usually separate, sometimes confluent, orange-brown in herbarium specimens. Sporangial

[1] This study has been supported by a grant from the National Science Foundation.

galls composite, hemispherical or mound-shaped, 156–216μ high by 204–268μ broad, with a narrow or broad apical crater which sometimes may be subapical so that galls are asymmetrical; sheath 1–3 cells thick, sheath cells greatly enlarged. Resting-spore galls highly variable from simple to composite; composite galls subspherical with slightly constricted base, 144–160 × 148–172μ, hemispherical, 130–170μ high by 202–280μ broad, or broadly mound-shaped, 120–156μ high by 240–270μ broad; sheath 1–3 cells thick. Simple galls 50–66μ high by 90–194μ long, consisting of an enlarged slightly protruding epidermal cell.

On leaves and petioles of *Ranunculus occidentalis*, 4500 ft. alt., Horse Mt., and south fork of Eel River below Redway, Humboldt Co., Calif. (leg. J. P. Tracy, 7–11–1933 and 4–24–1932, resp.).

This diagnosis is based on a study of two collections of herbarium specimens which are labeled *S. anomalum*. This identification is obviously incorrect inasmuch as *S. anomalum* is a short-cycled species. As noted above this species varies markedly in the size and shape of its resting spores as well as by the type and structure of the resting-spore galls it induces on the host. So far no simple sporangial galls have been found, but it is quite possible that they may occur. In the herbarium material at hand the simple resting-spore galls occur mainly at the base of the petioles, and from this region upward may be found all gradations from simple, slightly protruding to broadly mound-shaped, hemispherical and subspherical, conspicuously protruding composite galls. The small spherical, oval and usually oblong resting spores noted above occur in the simple galls, and sometimes they may be smaller than the sporangia.

This is the first species I have studied which may be so frequently diheterogallic as well as compositely dihomeogallic in relation to its host, and because of the variations in resting spore size, and type and structure of galls, I regard it as a different and new species. So far only two other long-cycled species with prosori in the sporangial cycle are known to occur on *Ranunculus: S. ranunculi* on *R. pusillus* (Cook 1947, Karling 1955c) and *S. andinum* on *Ranunculus* sp. and *R. californicus* (Patouillard and Lagerheim 1895, Karling 1956d). Both of these species are compositely dihomeogallic, or, at least, no simple galls have been found in them. However, in both species the empty prosorus lies in the base of the infected cell as in *S. variabilum*, and their sori and sporangia also are yellowish-orange in color. *Synchytrium ranunculi* has much smaller prosori and sori, forms only a few small sporangia and thus appears to be quite different from *S. variabilum*. The latter resembles more closely *S. andinum* but differs from it by its marked variability in spore size as well as in gall types and structures. I have examined carefully *S. andinum* on *R. californicus* for simple galls, but so far none have been found.

Synchytrium parksii sp. nov. Prosoris ovalibus, 150–168 × 192–210μ; soris ovalibus, 168–204 × 208–288μ; sporangis numerosis, polyhedris, 43–

96μ; sporis perdurantibus subsphaericis, 120–138μ, ovalibus, 90–122 × 130–160μ, parietibus 3–3.2μ crassis, germinatione ignoto.

Specimen typicum in herb. Univ. California, Berkeley, conservatum, no. 9314.

Prosori ovoid, 150–168 × 192–210μ, with a light-amber wall, 2–2.4μ thick; usually lying in base of infected cell, occasionally at the side, when empty and collapsed. Sori ovoid, 168–204 × 208–228μ, with a light-amber wall, 1.8–2.4μ thick; plug between empty prosorus and sorus 14μ–20μ diam. Sporangia 50–90 per sorus, polyhedral, 43–96μ in greatest diam., with a hyaline wall, 1.5μ thick, and yellow content. Resting spores usually solitary and partly filling host cell, subspherical, 120–138μ, ovoid, 90–122 × 130–160μ, with a smooth wall, 3–3.2μ thick, and hyaline content; enveloping residue thick, hard, and reddish-brown; germination unknown.

Compositely dihomeogallic, galls usually crowded and confluent, protruding conspicuously, light brown. Sporangial galls dome-shaped to subspherical, 300–390μ high by 276–416μ broad, cupulate after dehiscing; sheath 3–5 cells thick, sheath cells greatly enlarged and thin-walled. Resting spore galls 330–366μ high by 280–370μ broad, sheath 3–5 cells thick.

On leaves and petioles of *Trifolium microdon*, Duzen River, Humboldt Co., Calif., U.S.A. (leg. H. E. Parks, 3–26–1931).

The sporangial and resting spore galls are usually confluent and abundant on the petioles and the midrib and margins of leaves as in *S. marginale*. On the petioles they may form conspicuous outgrowths or marked thickening of the organ in the infected region. The only other long-cycled species with a prosorus in its sporangial phase known to occur on *Trifolium* is *S. marginale* (Karling 1955b). The present species differs from it by larger prosori, sori, sporangia and resting spores, and induces larger galls. Except for its resting spores it differs in these respects also from the unidentified species described below. Also, the content of the resting spore in *S. marginale* is yellow, whereas in the present species it is hyaline. For the reasons given above I believe it is different from *S. marginale* and the following species, and I am diagnosing it as a new species. It is named after H. E. Parks, an avid collector of fungi in California.

Synchytrium sp. on Trifolium sp. and T. dichotomum. Prosori subspherical to ovoid, 108–115 × 120–130μ, with an amber wall, 2.8–3μ thick, lying in base of host cell when empty and collapsed. Sori usually oval, 116–120 × 150–168μ, with a light-amber wall, 1.5–2.2μ thick, and yellowish content; plug between sorus and empty prosorus 18–22μ diam. by 5–10μ thick in center. Sporangia 30–70 per sorus, polyhedral 40–60μ in greatest diam., unusually large ones 72–112μ, with a hyaline wall, 1.2–1.6μ thick and yellowish content. Zoospores unknown. Resting spores usually solitary, partly filling host cell, spherical, 78–120μ, oval, 62–78 × 84–108μ, oblong, 52–78 × 80–110μ, with a smooth, light-amber to amber exospore, 4–5.5μ, and a hyaline endospore, 1.5–2μ; enveloped by a dense, crumbly, hard and flinty layer of residue which fills remainder of host cell; germination unknown.

Compositely dihomeogallic, galls separate and scattered or crowded and

confluent. Sporangial galls yellowish to tan, protruding conspicuously, largely superficial with a slightly constricted base, 300–364μ high by 390–420μ broad, usually cupulate after dehiscing; sheath 3–6 cells thick, cells greatly enlarged, thin-walled. Resting spore galls frequently confluent causing large, irregular or globular outgrowths or malformations, 2–10 mm diam., separate galls subspherical, 251–310μ high by 246–408μ broad; sheath 3–5 cells thick, walls of some sheath cells greatly thickened and lignified.

On leaves, petioles and stems of *Trifolium* sp., Ridgewood Ranch, Mendocino Co., Calif., (leg. H. E. Park, 5–10–1925) and *T. dichotomum*, Miranda, Humboldt Co., Calif., U.S.A. (leg. J. P. Tracy, 5–5–1929; spec. no. 28869, Univ. Calif., Berkeley).

The fungus on *Trifolium* sp. has slightly smaller resting spores than the one on *T. dichotomum*, but otherwise they appear to be identical as far as can be determined from the herbarium material. In the resting-spore galls caused by both fungi the wall of the infected cell may be up to 5–7μ thick and lignified. Similar changes extend to the walls of numerous sheath cells or to portions of the walls so that in fixed and stained sections the galls have a striking appearance as far as staining reaction is concerned. In some galls a single layer of compressed cells next to the infected one are thick-walled, and in others only some cells or one of their walls is thickened and lignified. Also, the angles or points where several cells meet may be thickened. As a result the galls are tough and woody in texture and very difficult to dissect.

This species is very similar to *S. marginale* on *T. carolinianum* by the size of its prosori, sori, sporangia and resting spores, but its sporangial and resting-spore galls are considerably larger than those caused by *S. marginale*. Furthermore, it causes thickening and lignification of the infected and sheath cell walls which apparently *S. marginale* does not cause. However, the size of the galls and differentiation of the host cell walls are probably due to differences in host reaction and may not be very significant. Therefore, it is quite possible that this species will prove to be identical to *S. marginale*.

Synchytrium sp. on Trifolium involucratum. Prosori subspherical, 118-125μ, yellow, with a light-amber wall, 2–3μ thick, lying in base of infected cell when empty and collapsed. Sori subspherical, 120–150μ, or ovoid, 115–125 $\times$ 138–168μ, with a hyaline wall, 2.5μ thick, and yellow content; plug between sorus and empty prosorus 15–18μ diam. and 5–7μ thick in center. Sporangia 50–70 per sorus, polyhedral 30–43μ in greatest diam., with a thin hyaline wall and yellow content. Zoospores unknown. Resting spores usually solitary and filling part of host cell, ovoid, 180–194 $\times$ 220–240μ, with an amber exospore, 4–4.5μ thick, and a thin hyaline endospore; enveloped by a dense, hard and flinty layer of residue which fills remainder of host cell; germination unknown.

Compositely dihomeogallic, galls separate and scattered or usually crowded and confluent. Sporangial galls protruding conspicuously and largely superficial when separate, tan to yellowish, subspherical, 230–312μ high by 240–370μ broad; sheath 3–5 cells thick. Resting-spore galls usually

on petioles and stems, usually crowded and confluent, forming thick, dark-brown crusts or hard globular outgrowths, 2–8 mm diam. at base of leaves, subspherical when separate, 400–588μ high by 410–624μ broad; sheath 4–6 cells thick, walls of sheath cells greatly thickened and lignified with scalariform perforations.

On leaves, petioles and stems of *Trifolium involucratum*, Cape Mendocino, Humboldt Co., Calif., U.S.A. (leg. J. P. Tracy, 5–20–1933; spec. no. 12237, Univ. Calif, Berkely).

Whether this is the same or a different species from the one described above is uncertain. Its prosori and sori are similar in size, and the endospore of the resting spore is quite distinct and visible as in the previous species. Also, the sheath cells of the resting-spore galls are somewhat similarly modified, and both species may cause similar outgrowths or malformations on the host where the resting-spore galls are confluent. As to differences, the sporangia of species on *T. involucratum* are smaller and its resting spores are much larger than those of the previous species. Also, it causes larger galls, and the thickened sheath cell walls have scalariform perforations.

This species is similar to *S. marginale* also by the size of its prosori, sori, and sporangia, but its resting spores are approximately twice as large as those of the former species. Furthermore, the content of the resting spore is hyaline. On these grounds, it appears to be a different species, but this cannot be determined with certainty until it as well as *S. marginale, S. parksii* and the fungi on *Trifolium* sp. and *T. dichotomum* have been studied more intensively from living material and host range studies have been made.It is to be noted that all of these species on *Trifolium* are compositely dihomeogallic, long-cycled and develop a prosorus in the sporangial phase which lies in the base of the infected cell. It is quite probable that they will prove to be closely related.

SUMMARY

1. Two new species, *S. variabilum* and *S. parksii* were found on *Ranunculus occidentalis* and *Trifolium microdon* in California. These are long-cycled and develop a prosorus in the sporangial phase, and for this reason they are placed temporarily in the subgenus *Microsynchytrium*.

2. In addition two unidentified species were found on *Trifolium* sp., *T. dichotomum* and *T. involucratum*. These are long-cycled also, resemble *S. marginale* in some respects, and are included provisionally in *Microsynchytrium*.

Department of Biological Sciences, Purdue University
Lafayette, Indiana

Literature Cited

Cook, M. T. 1947. Species of *Synchytrium* in Louisiana. IV. Two new species of *Synchytrium*. Mycologia **39**: 351–357.

Karling, J. S. 1955a. Observations on Spegazzini's and other Argentinean species of *Synchytrium*. Lloydia **18**: 1–24.

———. 1955b. Additional species of *Synchytrium* with prosori. Bull. Torrey Club **82**: 446–462.

———. 1955c. *Synchytrium ranunculi* Cook. Mycologia **47**: 130–139.

———. 1956a. *Synchytrium fulgens* in relation to other species on onagraceous hosts. Am. Jour. Bot. **43**: 61–69.

———. 1956b. Undescribed species of *Synchytrium*. Mycologia **48**: 83–98.

———. 1956c. Canadian species of *Synchytrium*. Canad. Jour. Bot. **34**: 406–416.

———. 1956d. New and unidentified species of *Synchytrium*. I. Sydowia **10**: (*In press*)

Patouillard, N. & Lagerheim, G. 1895. Champignons de l'equateur. Bull. l'Herb. Boiss **3**: 53–74.

BULLETIN OF THE TORREY BOTANICAL CLUB
VOL. 83, No. 6, pp. 421–427 DECEMBER, 1956

ASEPTIC STUDIES ON METABOLISM OF NITROGENOUS COMPOUNDS IN PLANTS[1]

L. G. NICKELL

With the exception of auxins and auxin antagonists, there have been very few extensive investigations of the metabolite-antimetabolite relationships in higher plants. The work done, thus far, has utilized as test materials a variety of plant systems including *Avena* coleoptile sections, decotylised pea seedlings, and excised corn embryos. All of these test objects require considerable work prior to their use in experimentation. One of the purposes of this presentation is to point out the ease with which another test material can be handled. That material is the tiny duckweed plant (*Lemna minor*) rendered aseptic by appropriate treatment and readily maintained under aseptic conditions. The advantages of using this plant for physiological studies have been discussed by several investigators (Steinberg 1941, Thimann and Edmondson 1949) and this point will not be elaborated further here. Rather, let us discuss the results of experiments using the duckweed and compare them with those obtained using other test objects.

The basal liquid synthetic medium used throughout these studies consists simply of a few salts, sucrose, three vitamins, and trace elements (Table 1) (Nickell 1951, Nickell and Finlay 1954). The pH of this medium

TABLE. 1. *Composition of basal medium.*

KNO	0.002 M	Thiamine	100 γ/L
$Ca(NO_3)_2$	0.003 M	Pyridoxin	800 γ/L
KH_2PO_4	0.001 M	Nicotinamide	800 γ/L
$MgSO_4$	0.001 M	B	0.1 ppm
$CaCl_2$	0.003 M	Mn	0.1 ppm
KCl	0.002 M	Zn	0.3 ppm
$MgCl_2$	0.001 M	Cu	0.1 ppm
Sucrose	2%	Mo	0.1 ppm
		Fe	0.5 ppm

is about 5.0 without adjusting. Any change in pH due to the addition of a test compound was corrected by the addition of NaOH or HCL. Test solutions were made up at ten times the highest level to be tested, sterilized by sintered-glass filtration, and added to the sterile basal medium aseptically to give the desired concentrations. All experiments were run in quintuplicate. Experimental transfers for each experiment were accomplished by

[1] Presented at a symposium on "Survey of Current Research in Plant Tissue Cultures" held at the annual meeting of the Tissue Culture Association, Philadelphia, Penna., April 5, 1955.

placing a microorganism-free rosette of four fronds in each flask; all transfers for a given experiment coming from one stock flask. Growth during the test period was in an air-conditioned culture room in the light with controlled temperature at 22.5° C. The results are compared here on the basis of wet weights. In general, effects on wet weight are similar to the effects on frond multiplication and dry weight. As in some instances there are also effects on leaf size, it was decided to express the results in terms of wet weight.

Canavanine. The amino acid canavanine is a structural analogue of arginine, differing from it in possessing an —O— in place of one of its —CH_2 groups. It causes an inhibition of growth in fungi, (Horowitz and Srb 1948), bacteria (Volcani and Snell 1948), and higher plants, (Bonner 1949a and b, Fries 1954, Wright and Srb 1950), an inhibition which can be overcome partially or completely by arginine.

The effects of canavanine on the growth of *Lemna minor* are shown in the top line of Table 2. A level of 10 ppm is not lethal, but it permits little growth (about 15% of the control). This is the level which was used subsequently in order to test the ability of certain amino acids to overcome this inhibition. The amino acids tested and their effects on the growth of duckweed are also shown in Table 2. Arginine showed a significant stimulation

TABLE. 2. *Effect of amino acids on growth of Lemna minor.*

Amino Acid	% of Control Wet Weight				
	1 ppm	5 ppm	10 ppm	50 ppm	100 ppm
Arginine	+65	+90	+95	+ 95	+100
Ornithine	0	0	+85	+140	+150
Citrulline	+10	+35	+80	+140	+150
Isoleucine	+25	+25	+25	+120	+ 25
Lysine	0	0	0	0	− 60
Canavanine	−25	−75	−85		

of growth at all levels. The other members of its cycle, ornithine and citrulline, showed considerable stimulation at levels of 10 ppm and over. Isoleucine showed a slight increase at all levels and a considerable stimulation at 50 ppm. Lysine had little effect except at 100 ppm where it was quite inhibitory.

When added to media containing 10 ppm of canavanine, lysine and isoleucine were completely ineffective in overcoming the inhibition. (Table 3). Arginine and citrulline not only overcame the inhibition, but at their higher levels caused a slight stimulation (over controls with no additions). Ornithine caused no stimulation, but almost succeeded in completely overcoming the inhibition.

Since arginine at 50 ppm was effective in overcoming the inhibition of

10 ppm of canavanine, various levels of these two analogs were tested, always in the ratio of 5:1. At levels of 5, 10, 20 and 50 ppm of canavanine, the inhibition was completely overcome by five times that amount of arginine. This did not hold for higher levels of canavanine.

How do these results compare with those of other investigators using different plant material as test objects?

Bonner working with *Avena* coleoptile sections found that the growth inhibition of canavanine was appreciably overcome by arginine, lysine, and glumatic acid (Bonner 1949a and b). Wright and Srb (1950) using excised maize embryos found arginine, citrulline, ornithine, glutamic acid, lysine, and possibly methionine, effective in counteracting this inhibition. Fries (1954) used decotylised pea seedlings and found arginine, ornithine, and citrulline to be equally active in removing this growth inhibition. He did not, however, find any activity of this nature in lysine, methionine, or glutamic acid.

TABLE. 3. *Ability of certain amino acids to overcome canavanine inhibition (10 ppm).*

Amino Acid	% of Control Wet Weight					
	0 ppm	1 ppm	5 ppm	10 ppm	50 ppm	100 ppm
Arginine	− 85	− 85	− 85	− 75	+ 25	+ 5
Ornithine	− 85	− 85	− 85	− 80	− 40	− 15
Citrulline	− 85	− 85	− 85	− 80	− 15	+ 35
Isoleucine	− 90	− 90	− 90	− 90	− 80	− 80
Lysine	− 90	− 85	− 85	− 85	− 85	− 80

These results with duckweed are, in this respect, in agreement with those of Fries, demonstrating the significance of structural similarity, as arginine and its precursors alone were active in overcoming the canavanine inhibition.

The findings with maize embryos and pea seedlings that (a) every concentration of arginine tested removed part of the inhibition, but that (b) no concentration removed it completely, are different from the results with duckweed. As can be seen in Table 3, when 10 ppm of canavanine are present, levels of arginine below 10 ppm have no effect, whereas 50 ppm more than completely overcomes the inhibition.

Adenine and 2,6-diamino-purine. It has been known for some time that various complex organic materials furnish factors which affect the growth of duckweed plants (Clark 1930, and Roller 1931, Gorham 1945). We became interested in determining what some of the compounds are in these complex materials that cause growth stimulation of duckweeds. Using *Lemna minor* as our test plant, we found that under our test conditions, adenine caused a considerable increase in growth (Nickell 1955). Tests with

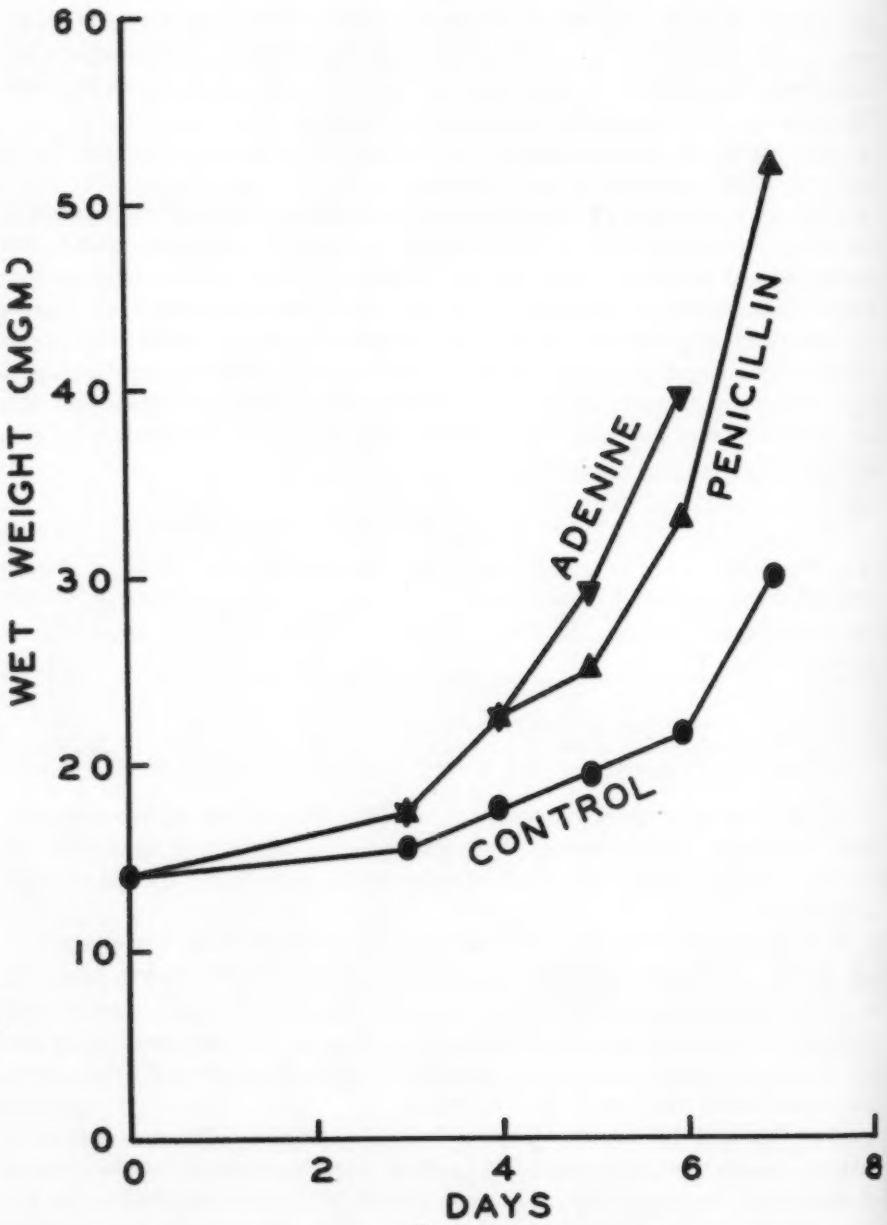


FIG. 1.

related purines showed that guanine was an active as adenine, and that xanthine and hypoxanthine were active but less so than adenine and guanine. Furthermore, tests with adenine-containing compounds (adenosine, adeno-

sine-3-phosphoric acid, ATP) showed that all of them caused a growth stimulation as great or greater than caused by adenine, with the exception of adenosine-5-phosphoric acid.

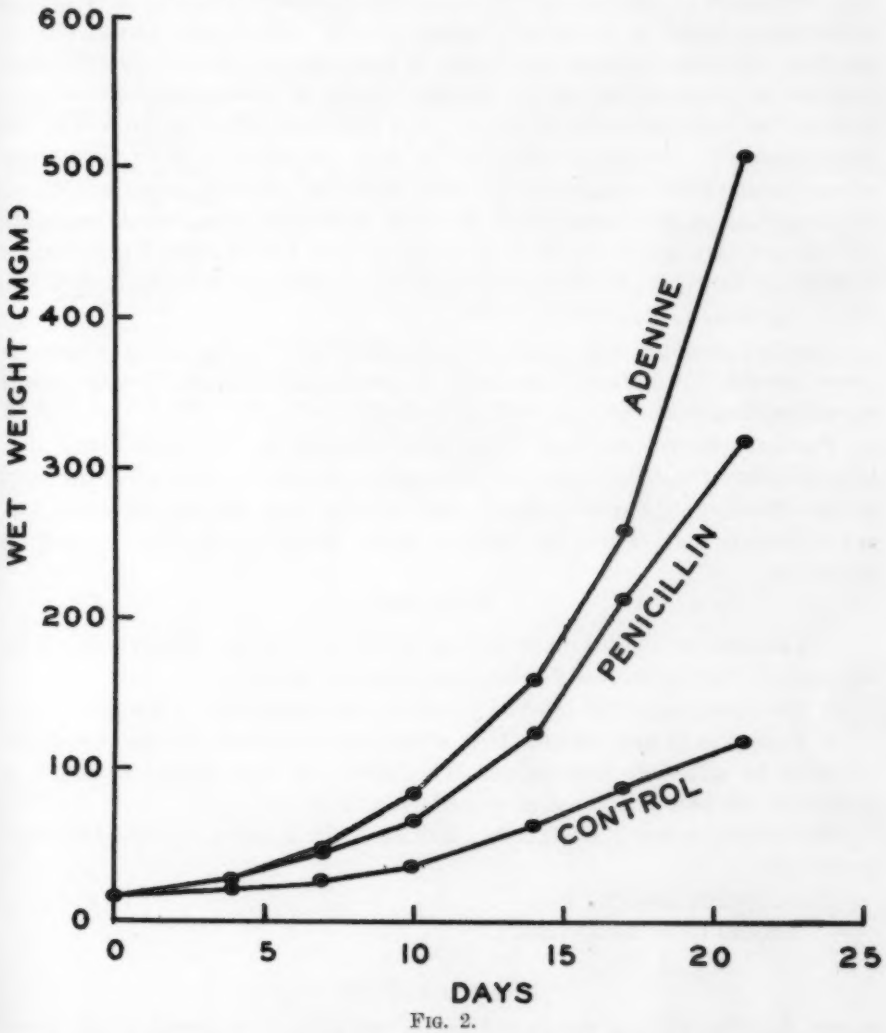


FIG. 2.

The inclusion of 2,6-diamino-purine in the basal medium caused an inhibition of growth which could be almost completely reversed by adenine (Nickell 1955). The ratio at which no inhibition occurs is about 20:1 of adenine to 2,6-diaminopurine. This holds for levels of 0.1 and 1.0 ppm of diaminopurine. Higher levels have not been tested.

Another purine analogue, 6-mercaptopurine, on the contrary, does not

have an inhibitory action but a stimulatory one on duckweed growth within the range of 1–10 ppm.

Time studies with adenine and penicillin. It has been shown that several antibiotics at certain concentrations will stimulate the growth of *Lemna minor* when added to the basal medium (Nickell and Finlay 1954). One of the most effective of these antibiotics is penicillin G. Since penicillin and adenine are representatives of different types of biologically-active compounds, the question comes to mind, "Are they both affecting growth in the same manner?". Dosage-response series with penicillin G show that maximum stimulation is obtained at 20 ppm, while for adenine maximum stimulation occurs in the presence of 40 ppm. However, when these two compounds are both added, each at its optimal level for growth, a stimulation is obtained which is greater than when either is used alone, indicating a difference in their mode of action.

Another question which arises concerning these compounds which increase growth is, "How do they act?". Is this stimulation due to a shortened lag phase, to a faster growth rate, or to both?

Figure 1 shows that both compounds shorten the lag period and that this difference from the control is noticeable within three days after the start of the experiment. Figure 2 shows quite clearly that the growth rates, too, are different, that caused by adenine being greater than that caused by penicillin.

SUMMARY

1. Canavanine inhibition of *Lemna minor* growth can be overcome with members of the structurally related arginine cycle.

2. 2,6–Diaminopurine inhibition can be overcome with adenine.

3. Penicillin G and adenine both stimulate the growth of duckweed, apparently by different mechanisms. This effect, in both cases, is due to a shortened lag period and an increased growth rate.

PHYTOCHEMISTRY LABORATORY, BIOCHEMICAL RESEARCH AND DEVELOPMENT DEPT.

CHAS. PFIZER AND CO., INC.

BROOKLYN 6, NEW YORK

Literature Cited

Bonner, J. 1949a. Limiting factors and growth inhibitors in the growth of the *Avena* coleoptile. Am. Jour. Bot. **36**: 323–331.

1949b. Relations of respiration and growth in the *Avena* coleoptile. Am. Jour. Bot. **36**: 429–436.

Clark, N. A. 1930. "Auximones" and the stimulation of *Lemna* by organic matter. Science **71**: 268–269.

Clark, N. A. & Roller, E. M. 1931. The stimulation of *Lemna major* by organic matter under sterile and non-sterile conditions. Soil Sci. **31**: 299–308.

Fries, N. 1954. Chemical factors controlling the growth of the decotylised pea seedling. Symb. Bot. Upsal. **13**: 1–83.

Gorham, P. R. 1945. Growth factor studies with *Spirodela polyrrhiza* (L.) Schleid. Am. Jour. Bot. **32**: 496–505.

Horowitz, N. H. & Srb, A. M. 1948. Growth inhibition of *Neurospora* by canavanine, and its reversal. Jour. Biol. Chem. **174**: 371–378.

Nickell, L. G. 1951. Embryo culture of weeping crabapple. Proc. Amer. Soc. Hort. Sci. **57**: 401–405.

1955. Effects of anti-growth substances in normal and atypical plant growth. "Anti-metabolites and Cancer", AAAS, pp. 129–151.

Nickell, L. G. & Finlay, A. C. 1954. Growth modifiers. Antibiotics and their effects on plant growth. Jour. Agri. and Food Chem. **2**: 178–182.

Steinberg, R. A. 1941. Use of *Lemna* for nutrition studies on green plants. Jour. Agri. Res. **62**: 423–430.

Thimann, K. V. & Edmondson, Y. H. 1949. The biogenesis of the anthocyanins. I. General nutritional conditions leading to anthocyanin formation. Arch. Biochem. **22**: 33–53.

Volcani, B. E. & Snell, E. E. 1948. The effect of canavanine, arginine, and related compounds on the growth of bacteria. Jour. Biol. Chem. **174**: 893–902.

Wright, J. E. & Srb, A. M. 1950. Inhibition of growth in maize embryos by canavanine and its reversal. Bot. Gaz. **112**: 52–57. 1950.

BULLETIN OF THE TORREY BOTANICAL CLUB
VOL. 83, No. 6, pp. 428–434 DECEMBER, 1956

THE CYTOLOGY OF XANTHISMA TEXANUM D.C. IV. MEGASPOROGENESIS AND EMBRYO SAC FORMATION, POLLEN MITOSIS AND EMBRYO FORMATION[1, 2]

C. A. BERGER, E. J. FEELEY AND E. R. WITKUS

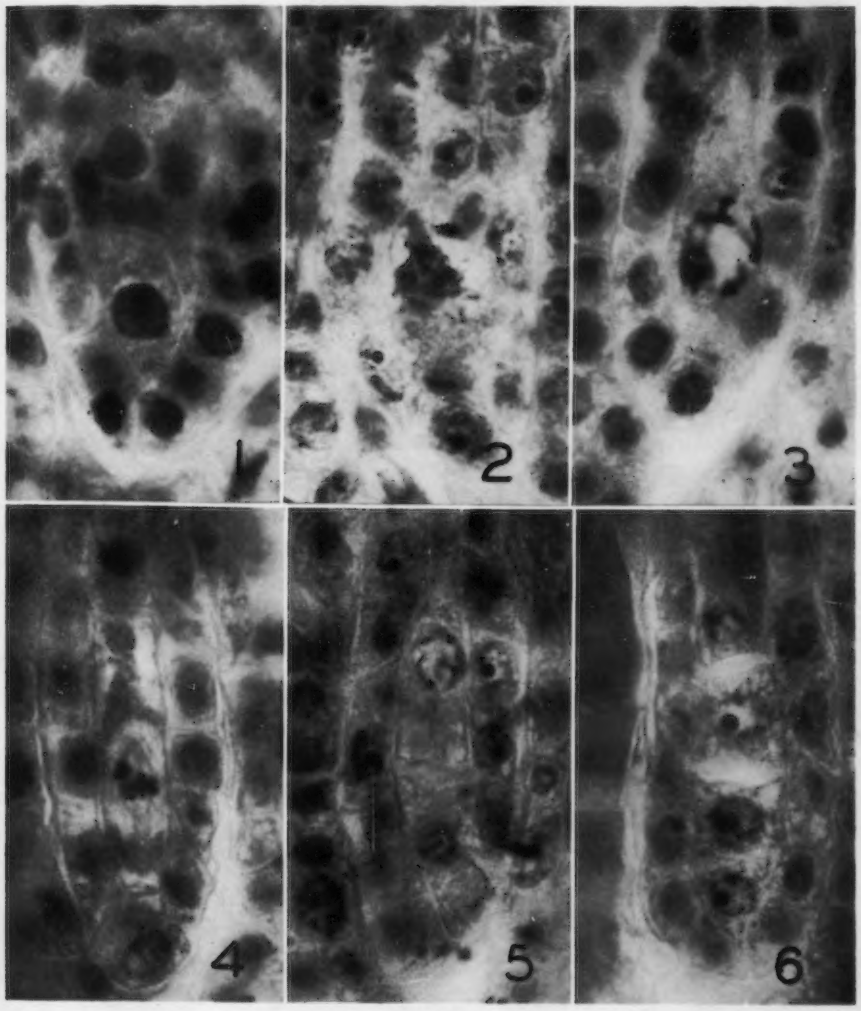
Cytological studies of *Xanthisma texanum* D.C. (Berger and Witkus 1954) have disclosed an interesting phenomenon. Root tip smears have shown the somatic chromosome number to be eight, while the meiotic divisions of the pollen mother cells showed four bivalents in some plants and five bivalents in others. Contrary to what would be expected, the five bivalent plants have only eight chromosomes in the root tip cells as do the four bivalent plants. Since these preliminary investigations, further work has revealed other interesting features (Witkus, Lowery and Berger 1955). In studying microsporogenesis, plants were found having four bivalents plus one univalent, five bivalents plus one univalent and six bivalents. In addition one plant was found having nine bivalents. This plant may be a polyploid of the four bivalent and one univalent type. In the diploid plants numbers higher than eight are due to a small supernumerary chromosome, of which one, two, three or four may be present in the shoot cells of different plants but never in the roots. Because of these findings it was decided to study megasporogenesis, embryo sac formation, pollen mitosis and embryo formation in the following types of plants: four bivalent, four bivalent and one univalent, five bivalent and one univalent, six bivalent and nine bivalent. Particular attention was paid to the behavior of the supernumerary chromosomes.

Material and methods. For this study only those plants were used whose chromosomal type had previously been determined. Inflorescences were removed at various stages of development and were placed in Carnoy's (1:1:3) solution for one half hour. They were then placed in Craf's fixative for twenty-four hours. After fixation the entire inflorescence was washed and dehydrated in a graded series of alcohols. After 70% alcohol the inflorescence was dissected and the individual flowers were then further dehydrated and imbedded in paraffin. Longitudinal sections were cut at ten, fifteen or twenty microns and stained in Heidenhain's iron-alum hematoxylin. For the later stages in development sections cut at ten microns were found best, while sections cut at twenty microns were best for earlier stages.

[1] This investigation was aided by a Grant (G2235) from the National Science Foundation.

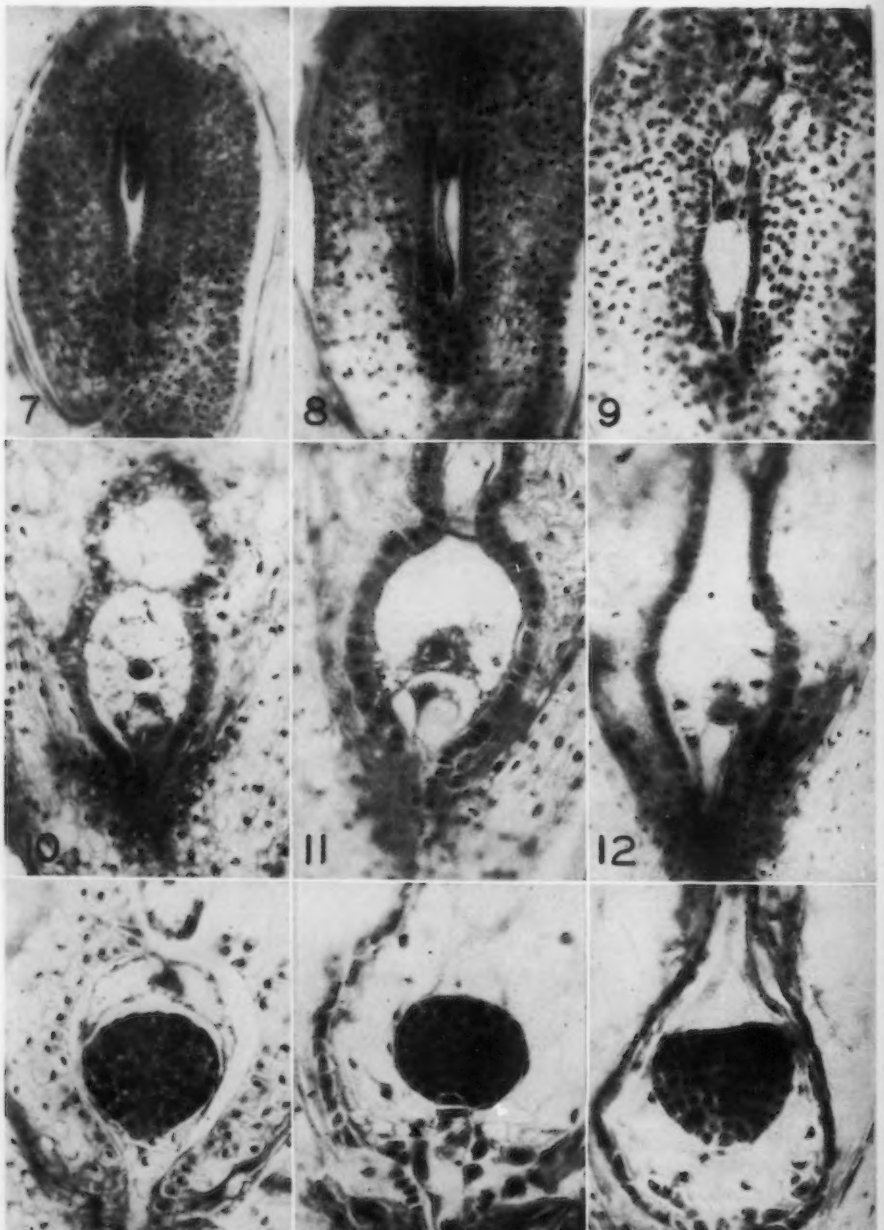
[2] Illustrations published with the assistance of the Lucien M. Underwood Memorial Fund.

Observations. Megasporogenesis and embryo sac development. The ovary of *Xanthisma texanum* consists of a single ovule, which is anatropous, so that the micropyle and funiculus lie close to each other. The megaspore



FIGS. 1–6. Photomicrographs of longitudinal sections of ovules of *Xanthisma texanum* illustrating various stages in megasporogenesis. Magnification × 750. FIG. 1. Megaspore mother cell. FIG. 2. Zygotene synezesis. FIG. 3. Diakinesis. FIG. 4. Metaphase I. FIG. 5. Two celled stage. FIG. 6. Four celled stage (4 megaspores).

mother cell is located near the micropylar end and is surrounded by a single layer of cells, the nucellus (fig. 1). This structure is overgrown by the integument consisting of four cell layers. Meiosis follows the normal pattern.


7
8
9
10
11
12
13
14
15

It was found that the number of supernumerary chromosomes in the megaspore mother cell is the same as that found in the microspore mother cell.

Figures 2 to 6 show various stages in meiosis of the megaspore mother cell. These photomicrographs are all from the five bivalent and one univalent type plant. In figure 4 only four of the bivalents are evident. The additional bivalent and univalent are present in the next section. After the first meiotic division a wall forms between the two daughter nuclei (fig. 5). The second meiotic division may not occur simultaneously in each cell of the secondary megasporocytes. At the completion of the second meiotic division cross walls form again, producing a linear quartet of megaspores (fig. 6). If the supernumerary chromosome exists as a univalent it usually undergoes a reductional division at anaphase I and moves undivided to one pole. In the second division it divides equationally. If the supernumerary chromosome exists as a bivalent it behaves as do other bivalents. When the supernumerary chromosome is present as a univalent, the resultant egg nucleus may or may not have the supernumerary chromosome.

During the meiotic divisions there has been considerable enlargement of the integument and it now consists of ten cell layers. Generally the three megaspores nearest the micropyle disintegrate, leaving one functional chalazal megaspore. At the disintegration of the three megaspores, the nucellus also disintegrates (fig. 7). At this time the inner layer of the integument differentiates to form an integumentary tapetum or nutritive layer (fig. 7). The cells in this layer differ from the other cells in the integument by their radial elongation. They remain uninucleate. An occasional case was noted in which two of the micropylar megaspores disintegrated, along with the chalazal megaspore, leaving the megaspore below the chalazal one as the functional megaspore.

Embryo sac formation in *Xanthisma texanum* was thus found to be of the "Normal type". Before the first mitotic division the functional megaspore elongates considerably. After the first division the daughter nuclei are separated by a large central vacuole. The binucleate embryo sac emerges through the disintegrating nucellar layer. In figure 8 the remnants of the nucellus are still evident. The two nuclei divide, yielding a four-nucleate embryo sac (fig. 9). After the final mitotic division to yield the eight-nucleate embryo sac, cross walls are formed dividing the embryo sac into a

FIGS. 7–15. Photomicrographs of longitudinal sections of the embryo sacs in various stages of development. Magnification ×500. FIG. 7. Three micropylar megaspores degenerating. Single functional chalazal megaspore remaining. FIG. 8. Two nucleate embryo sac. FIG. 9. Four nucleate embryo sac. FIG. 10. Secondary nucleus (fused polar nuclei), egg cell and two synergid cells. FIG. 11. Primary endosperm nucleus, zygote, vacuolated synergid. FIG. 12. Four celled embryo. FIG. 13. Spherical embryo. The endosperm has failed to develop and is only a single cell. FIG. 14. Spherical embryo with normal endosperm. FIG. 15. Heart-shaped embryo.

seven celled structure, three antipodal cells at the chalazal end, one central cell which is binucleate, and the egg apparatus, consisting of an egg cell and two synergid cells at the micropylar end. The binucleate central cell contains the two polar nuclei which soon fuse to form the secondary nucleus. The secondary nucleus and the egg apparatus are indicated in figure 10.

Microsporogenesis and pollen mitosis. A study of longitudinal sections of complete inflorescences was made to correlate the various stages in microsporogenesis with the stages of megasporogenesis in the same flower. It was evident that the stages of microsporogenesis precede those of megasporogenesis.

At the time the megaspore mother cell differentiates from other nucellar tissue, the microspore mother cells are in zygotene, pachytene and diplotene of the first meiotic prophase. At early zygotene of the megaspore mother cell, second meiotic divisions are present in the microsporocytes. At late zygotene of the megaspore mother cell, tetrads of spores are already evident in the microsporocytes. This tetrad arrangement persists until the diplotene stage of megasporogenesis when it is lost. By the end of the first meiotic division in the megasporocyte, a thick wall is evident around the individual pollen grains. The pollen grains remain uninucleate until the time of disintegration of the three abortive megaspores. At this time the single pollen grain nucleus undergoes mitotic divisions.

Mitosis was studied in the pollen grains and particular attention was paid to the behavior of the supernumerary chromosomes. The divisions were found to be normal including the behavior of the supernumerary chromosomes. The microspore when first formed has dense cytoplasm and a centrally located haploid nucleus. Prior to the first pollen grain mitosis the cell increases in size and a large central vacuole becomes evident. The nucleus is forced against the wall. This vacuolated condition persists until the generative and tube cells are formed. At that time the cytoplasm again appears dense and free of vacuoles.

Fertilization and embryo formation. Following fertilization the primary endosperm cell becomes highly vacuolated. As indicated in figure 11 the large primary endosperm nucleus is surrounded by a thin film of cytoplasm connected by fine strands to the peripheral cytoplasmic layer. Only one synergid is evident after fertilization.

Generally the primary endosperm nucleus divides before the zygote. This precocious activity of the endosperm is maintained so that even when the embryo is still few-celled, the endosperm consists of many cells (fig. 12). In a few cases, however, the division of the endosperm was found to be delayed. In one instance a spherical embryo was present while the endosperm had not yet divided (fig. 13). It is possible that in this instance the polar fusion nucleus had not been fertilized.

After fertilization, the resulting zygote assumes a more pronounced pear shape and the vacuole in the narrow micropylar end of the embryo sac enlarges. The plane of the first division of the zygote is transverse, producing a basal cell and a much smaller terminal cell. The basal cell was usually seen to divide first, always in a transverse plane. The terminal cell division occurred soon after, in a longitudinal plane. The resulting four celled embryo has its cells arranged in three layers (fig. 12). The eight celled embryo is derived from divisions of each of the cells of the four celled embryo. It consists of four layers. The upermost contains four cells, formed by the development of two longitudinal walls at right angles to the initial wall. The second layer from the top consists of two cells, separated from each other by a longitudinal wall. The two basal cells are separated by a transverse wall. Thus in the eight celled embryo, the three lower layers have been derived from the basal cell and the upper layer has been derived from the terminal cell of the two celled embryo. During the early development of the embryo the supernumerary chromosomes divide normally.

The fate of each cell and of the layers of cells was not followed after the eight celled stage. Succeeding divisions form a spherical embryo of many cell layers (fig. 14), which soon changes into a heart shaped embryo (fig. 15).

Discussion. In 1934 Hasegawa described irregular behavior of the B-chromosomes of rye during the first pollen grain mitosis. In late anaphase and in early telophase of the first division, they were often found lagging behind. In some cases the halves of the extra chromosomes underwent nondisjunction. Hasegawa (1934) found that in most cases of nondisjunction the extra chromosome was included in the generative nucleus and not in the vegetative nucleus. Muntzing (1945) reported similar findings in the same plant. In addition he found that nondisjunction is equally well developed in the ovule as in the pollen. He also indicated that the fragments generally pass to the male and female gametes. This is in accordance with Hasegawa's observation on the behavior of the fragments in pollen mitosis. Ostergren (1947) had reported a mechanism resembling this in *Anthoxanthum*, except that here the nondisjunction occurs only in the pollen. In *Anthoxanthum* the accessory chromosomes do not divide at the first pollen grain division but do divide at the second division. Darlington and Thomas (1941) noted that in *Sorghum*, plants with extra chromosomes have extra divisions of the vegetative nucleus rapidly following the primary division. The first pollen grain division is delayed by the presence of extra chromosomes. Its course, however, is always normal. At the second division the extra chromosomes always pass to the generative pole undivided and so double in number. When only two generative nuclei are formed, one or both may produce sperm. Three, four or five generative nuclei, however, kill the pollen grain. The extra divisions are thus considered malignant. In *Xan-*

thisma no such phenomena were observed. In pollen grain mitosis and in the female gametophyte no evidence of non-disjunction or of lagging of the supernumerary chromosomes was found.

SUMMARY

1. The embryo sac development in *Xanthisma texanum* was found to be the "Normal type".

2. No abnormal behavior of the supernumerary chromosomes was noted during megasporogenesis and embryo sac formation.

3. It was found that the number of supernumerary chromosomes in the megaspore mother cell is the same as that found in the microspore mother cell.

4. No abnormal behavior of the supernumerary chromosomes was noted during pollen grain mitosis.

BIOLOGICAL LABORATORY, FORDHAM UNIVERSITY
NEW YORK 58, N. Y.

Literature Cited

Berger, C. A. & Witkus, E. R. 1954. The cytology of *Xanthisma texanum* D. C. I. Differences in the chromosome number of root and shoot. Bull. Torrey Club. **81**: 489–491.

Darlington, C. D. & Thomas, P. T. 1941. Morbid mitosis and the activity of inert chromosomes in *Sorghum*. Proc. Royal Soc. London. **130**. 127–150.

Hasegawa, N. 1934. A cytological study on 8-Chromosome Rye. Cytologia. **6**: 68–77.

Müntzing, A. 1945. Cytological studies of extra fragment chromosomes in rye. II. Transmission and multiplication of standard fragments and iso fragments. Hereditas **31**: 457–477.

östergren, G. 1947. Heterochromatic B-chromosomes in *Anthoxanthum*. Hereditas **33**: 261–296.

Witkus, E. R., Berger, C. A. & Lowery, T. J. 1955. The cytology of *Xanthisma texanum* D. C. II. Additional chromosome types. Bull. Torrey Club. **82**: 367–376.

BULLETIN OF THE TORREY BOTANICAL CLUB

VOL. 83, NO. 6, PP. 435–442 DECEMBER, 1956

TORREYA

An Annotated Preliminary Catalogue of the Vascular Flora of Rockland County, New York.

J. HARRY LEHR.

The compilation of this catalogue was begun in April 1952, but more study of the flora will be necessary before its completion. Nevertheless, the writer believes it incumbent upon him to publish this preliminary report now, for there may be, at present unknown to him, other workers in the larger area of which Rockland County is a part, to whom this list would be useful. In addition, the publication of this report may stimulate interest in the flora of the county by persons who do not know the variety and extent of its plant life.

The primary reason for undertaking this study was a desire to place on permanent record the present condition of the flora of Rockland County, an area which is rapidly undergoing the inevitable changes incidental to suburbanization; changes which are bound to influence the flora of the region in the near future. The county is composed of five townships: Ramapo, Clarkestown, Orangetown, Haverstraw, and Stony Point. Its total area is 172.6 square miles excluding the waters of the Hudson River to its center. Its altitude ranges from sea level to about 1240 feet. The location of reports and collections is given by townships except that in those instances where a plant is known from all five townships the term 'general' is used. In every instance the species named has been observed or collected in the field by the author. Specimens on deposit in the herbarium of the New York Botanical Garden are indicated by (H) following the annotation.

In this report the Latin names used and the sequence of families and genera are those given in Gray's Manual of Botany, 8th edition (Fernald 1950) although this does not imply that the author is in complete agreement with this work. For the sake of convenience, the species are arranged alphabetically. In an effort to attain some order out of the confusion that exists in respect to common names, the following publications have been used in giving a single common name for the plants. Ferns: Weatherby (1952); Grasses: Hitchcock (1950); Trees: Little (1953); Weeds: Muenscher (1953). When a plant is not listed in these publications, the common name used is the one the author has found in most general usage.

There is a minimum of botanical literature pertaining to the plants of Rockland County. A number of earlier local flora have implied the inclusion of this county: J. Torrey (1819, 1840, 1843); Leggett (1870–1874), Poggenburg et al (1888), Taylor (1915), House (1924), but their coverage has been superficial and these works did not annotate the county with sufficient care to be reliable. A number of short papers which refer to its plants were listed by House (1942) and in 1950 the New York State Museum prepared a list of all known Rockland County reports and vouchers but this list remains unpublished. Price (1949) presented a local paper and in addition, his personal notes have been checked by the author. Therefore, when an asterisk (*) precedes the name of a plant it indicates its first definitive record from the county, for completeness and dependability have been the main considerations of the writer in presenting, this, the first flora of Rockland County.

Spring Valley, New York.

Literature Cited

Fernald, M. L. 1950. Gray's Manual of Botany 8th Edition. New York.

Hitchcock, A. S. 1950. Manual of the Grasses of the United States. Revised by Agnes Chase, Washington.

House, H. D. 1924. Annotated List of the Ferns and Flowering Plants of New York State. Albany.

———— 1942. Bibliography of the Botany of New York State 1751–1940. Part 1, 2. Albany.

Leggett, W. H. 1870–1874. A Revised Catalogue of the Plants, Native and Naturalized, Within Thirty-Three Miles of New York. Bull. Torrey Club.

Little, E. L. Jr. 1953. Check List of Native and Naturalized Trees of the United States. Washington.

Muenscher, W. C. and Schumacher, G. J. 1953. List of Weeds of New York. Ithaca.

Poggenburg, J. F., et al. 1888. Preliminary Catalogue of Anthophyta and Pteridophyta Reported as Growing Spontaneously Within One Hundred Miles of New York City. New York.

Price, J. M. 1949. The Flowers That Bloom in the Spring in Rockland County. West Nyack, New York.

Taylor, N. 1915. Flora of the Vicinity of New York. New York.

Torrey, J., et al. 1819. A Catalogue of Plants, Growing Spontaneously Within Thirty Miles of the City of New York. Albany.

Torrey, J. 1840. Catalogue of Plants (of New York State). Albany.

———— 1843. A Flora of the State of New York. 2 vols. Albany.

Weatherby, Una F. 1952. The English Names of North American Ferns. Amer. Fern. Journ. **42**: 4, 134–151.

THE CATALOGUE

EQUISETACEAE

EQUISETUM

EQUISETUM ARVENSE L. Common Horsetail. General. (H)

*E. ARVENSE L., f. RAMULOSUM (Rupr.) Klinge. Stony Point, Ramapo. Damp sandy shore of ship basin, railroad embankment. (H)

*E. FLUVIATILE L. Swamp Horsetail. Ramapo. This species, at this its only station, was conspicuous in its absence of fertile stems. (H)

E. HYEMALE L. var. AFFINE (Engelm.) A. A. Eat. Scouring-rush. Ramapo, Orangetown. (H)

E. SCIRPOIDES Michx. Dwarf Scouring-rush. Ramapo. The author believes that this, the only station, is the southernmost one in the Northeastern United States. Altitude 650 feet. Steep, granitic rock of stream bank. (H)

E. SYLVATICUM L., var. PAUCIRAMOSUM Milde, f. MULTIRAMOSUM Fern. Wood Horsetail. Ramapo, Clarkestown. Each of the three stations were conspicuous in their absence of fertile stems. (H)

LYCOPODIACEAE

LYCOPODIUM

*LYCOPODIUM CLAVATUM L., var. MEGASTACHYON Fern. and Bissell. Ground Pine. Ramapo, Clarkestown. Fertile branches were found at only one of the three stations. (H)

L. COMPLANATUM L., var. FLABELLIFORME Fern. Ground Cedar. Ramapo, Clarkestown. (H)

L. LUCIDULUM Michx. Shining Club-moss. Ramapo, Clarkestown. (H)

*L. OBSCURUM L. Staghorn Club-moss. Ramapo, Clarkestown. (H)

SELAGINELLACEAE

SELAGINELLA

SELAGINELLA APODA (L.) Fern. Meadow Spike-moss. Ramapo. (H)

OPHIOGLOSSACEAE

BOTRYCHIUM

*BOTRYCHIUM DISSECTUM Spreng. Dissected Grape-fern. Ramapo. (H)

*B. DISSECTUM Spreng. f. ELONGATUM (Gilbert & Haberer) Weath. Ramapo. Al-

though there is variation in leaf-form among the individuals at these two stations, the majority of plants have the elongated basal segment typical of this form. (H)

*B. DISSECTUM Spreng. f. OBLIQUUM (Muhl.) Fern. Ternate Grape-fern. Ramapo. (H)

*B. DISSECTUM Spreng. f. ONEIDENSE (Gilbert) Clute (of Oneida Co., N.Y.) Clarkestown, the only station known. (H)

*B. MATRICARIAEFOLIUM A. Br. Matricary Grape-fern. Clarkestown, Ramapo. The author believes this is the southernmost station in the State. (H)

*B. MULTIFIDUM (Gmel.) Rupr. var. INTERMEDIUM (D. C. Eat.) Farw. Multifid Grape-fern. Ramapo. Old apple orchard. Altitude 420 feet. A single collection. The segments of this specimen have jagged indentations as opposed to the entire or lobulate segments in the typical variety. The author believes this is the southernmost station in the State. (H)

B. VIRGINIANUM (L.) Sw. Rattlesnake Fern. Ramapo, Orangetown. (H)

OPHIOGLOSSUM

*OPHIOGLOSSUM VULGATUM L. var. PSEUDOPODUM (Blake) Farw. Adder's-tongue. Ramapo. A single station. (H)

OSMUNDACEAE

OSMUNDA

OSMUNDA CINNAMOMEA L. Cinnamon Fern. General. This fern is considered a weed in New York State and it can be so classified in the County. (H)

O. CLAYTONIANA L. Interrupted Fern. General. (H)

O. REGALIS L. var. SPECTABILIS (Willd.) Gray. Royal Fern. General.

*O. REGALIS L. var. SPECTABILIS (Willd.) Gray f. ANOMALA (Farw.) Harris. Ramapo. A single station. (H)

POLYPODIACEAE

WOODSIA

*WOODSIA OBTUSA (Spreng.) Torr. Blunt-lobed Woodsia. Stony Point. A single station.

CYSTOPTERIS

*CYSTOPTERIS FRAGILIS (L.) Bernh. Fragile Bladder-fern. Ramapo, Clarkestown, Orangetown. (H)

ONOCLEA

ONOCLEA SENSIBILIS L. Sensitive Fern. General. This fern is considered a weed in New York State and this applies to its behavior in the County.

DRYOPTERIS

*DRYOPTERIS BOOTTII (Tuckerm.) Underw. Boott's Shield-fern. Ramapo. A single station. (H)

D. CRISTATA (L.) Gray. Crested Shield-fern. Ramapo. (H)

*D. CRISTATA (L.) Gray, var. CLINTONIANA (D. C. Eat.) Underw. Clinton's Shield-fern. Ramapo. A single station.

*D. GOLDIANA (Hook.) Gray. Goldies's Fern. Ramapo, Clarkestown. (H)

D. HEXAGONOPTERA (Michx.) Christens. Broad Beech-fern. Ramapo, Stony Point, Orangetown. (H)

D. MARGINALIS (L.) Gray. Marginal Shield-fern. General. (H)

D. NOVEBORACENSIS (L.) Gray. New York Fern. General. (H)

*D. PHEGOPTERIS (L.) Christens. Long Beech-fern. Ramapo. Sandstone ledges. The author believes this single station is the southernmost authenticated one in the State. (H)

D SPINULOSA (O. F. Muell.) Watt. Spinulose Shield-fern. General. Only the typical

species has been listed, since the writer has not completed his study of this variable taxon.

D. THELYPTERIS (L.) Gray, var. PUBESCENS (Lawson) Nakai. Marsh Fern. General. (H)

POLYSTICHUM

POLYSTICHUM ACROSTICHOIDES (Michx.) Schott. Christmas Fern. General. The most common fern in the County with the exception of the weed ferns. (H)

DENNSTAEDTIA

DENNSTAEDTIA PUNCTILOBULA (Michx.) Moore. Hay-scented Fern. General. This fern is also considered a weed in New York State and can be so classified in the County.

ATHYRIUM

ATHYRIUM FILIX-FEMINA (L.) Roth. Lady Fern. General. Only the typical species has been listed, the author not having completed his study of this variable taxon.

A. THELYPTERIOIDES (Michx.) Desv. Silvery Spleenwort. Ramapo.

*A. THELYPTERIOIDES (Michx.) Desv. f. ACROSTICHOIDES (Sw.) Gilbert. Ramapo. (H)

CAMPTOSORUS

CAMPTOSORUS RHIZOPHYLLUS (L.) Link. Walking Fern. Stony Point. This township contains the only limestone area in the County. (H)

ASPLENIUM

ASPLENIUM PLATYNEURON (L.) Oakes. Ebony Spleenwort. Ramapo, Clarkestown, Stony Point. (H)

A. TRICHOMANES L. Maidenhair Spleenwort. Stony Point. It is found only at the same two stations in which *Camptosorus rhizophyllus* grows. (H)

WOODWARDIA

*WOODWARDIA AREOLATA (L.) Moore. Narrow-leaved Chain-fern. Ramapo. Probably the station in the State farthest inland from the coastal region. Altitude 520 feet. (H)

*W. VIRGINICA (L.) Sm. Virginia Chain-fern. Ramapo. Found only in the Ramapo Mountain bogs at an altitude of about 1200 feet. (H)

PELLAEA

PELLAEA ATROPURPUREA (L.) Link. Purple Cliff-brake. Stony Point. Found only in the limestone area but not in association with either *Camptosorus rhizophyllus* or *Asplenium Trichomanes.* (H)

CHEILANTHES

*CHEILANTHES LANOSA (Michx.) D. C. Eat. Hairy Lip-fern. Stony Point. A single station. (H)

ADIANTUM

ADIANTUM PEDATUM L. Common Maidenhair. General. (H)

PTERIDIUM

PTERIDIUM AQUILINUM (L.) Kuhn var. LATIUSCULUM (Desv.) Underw. Common Brake. General. This is the fourth of the ferns considered as weeds in New York State and which deserve the same status in this County. (H)

POLYPODIUM

POLYPODIUM VIRGINIANUM L. Common Polypody. General. (H)

(To be continued)

Sporobolus cryptandrus (Torr.) A. Gray in the New Jersey Pine Barrens

Jack McCormick and Murray F. Buell

The sand dropseed, *Sporobolus cryptandrus* (Torr.) A. Gray, a species not previously found in New Jersey, was discovered in October, 1952, in a field at Mount Misery, Burlington County, New Jersey (Long. 74° 31′ W., Lat. 39° 55′ 10″ N.). The field, formerly an orchard, had been plowed 5 months earlier. Its vegetation consisted primarily of *Panicum virgatum* L., *P. capillare* L., and *Cyperus filiculmis var. macilentus* Fern.

Sporobolus cryptandrus has been reported to grow in 35 states from "Maine and Ontario to Alberta and Washington, south to North Carolina, Indiana, Louisiana, southern California, and northern Mexico." (Hitchcock and Chase, 1951). The nearest stations to the one here recorded are apparently those on Long Island, New York, reported by Burnham and Stewart (1914), Ferguson (1928), and Gleason (1937).

Specimens have been deposited in the Chrysler Herbarium of Rutgers University, the United States National Herbarium, and the herbaria of the New York Botanical Garden and the Philadelphia Academy of Science. The American Museum of Natural History, New York 24, New York, and Rutgers, The State University of New Jersey, New Brunswick, N. J.

Literature Cited

Burnham, S. H., and R. A. Latham. 1914. The flora of the town of Southold, Long Island. Torreya **14**: 229–254.

Ferguson, Wm. C. 1928. Contributions to the flora of Long Island, New York, fifth paper. Torreya **28**: 45–51.

Gleason, H. A. 1937. Wool-waste grasses at Yonkers. Torreya **37**: 15.

Hitchcock, A. S., and Agnes Chase. 1951. Manual of the grasses of the United States. U. S. Dept. Agric., Misc. Publ. 200, pp. 425–427.

Field Trip Reports

June 10. **Vicinity OF CHEESEQUAKE STATE PARK, MIDDLESEX COUNTY, N. J.** Although this date is usually late for spring flowering it was perfect for the cold, wet spring experienced this year.

Each member on the trip was assigned a species of *Quercus* (oak) and a study was made of all the oaks found in the area along the route of travel. Each worker counted the number of his particular oaks encountered and also made a record of putative hybrids based on morphological studies conducted in the field. *Quercus alba*, 32; *Q. borealis*, 19; *Q. coccinea*, 10; *Q. ilicifolia*, 21; *Q. marilandica*, 41; *Q. palustris*, 6; *Q. prinus*, 76; *Q. stellata*, 3; *Q. velutina*, 9. List of putative hybrids: *Q. ilicifolia* × *marilandica*, 7; *Q. marilandica* × *palustris*, 5; *Q. prinus* × *alba*; *Q. borealis* × *ilicifolia*; *Q. prinus* × (member of red oak group ?).

The small bog in the area has mostly been destroyed by gravel operations in the vicinity. The great abundance of *Deschampsia flexuosa* (hairgrass) made a very showy display in the pine woods. Attendance 7. Leader, David E. Fairbrothers.

June 17. The William L. Hutcheson Memorial Forest, East Millstone, N. J. The leader is the first Rutgers Forest Ecological Research Fellow, a fellowship made possible by the generosity of those who contributed funds before the purchase of the Forest. His research was explained and a map of the distribution of shrubs in the Forest was available. Late spring flowers and a variety of ecological aspects were to be seen along the pathway provided for visitors. Attendance 3. Leader, Carl D. Monk.

A Report From Your Field Chairman

A definite lack of interest has been shown by members of the Torrey Botanical Club in their field program during the past two years.

There are two problems which your Field Committee have noted. (1) It is very difficult to obtain qualified and interested trip leaders. The program is being carried by a few veterans. (2) The attendance by members on most of the scheduled trips has been extremely poor, thus discouraging the leaders we have been able to obtain.

The field program cannot be successful if the members refuse to support the Field Committee.

Inform the Field Chairman, at once, if you think the field program should be continued or disbanded. *DO NOT* say it should be continued unless you plan to support the program by attendance and/or leadership. A decision must be made by the end of January.—David E. Fairbrothers, Field Chairman, Botany Department, Rutgers University, New Brunswick, New Jersey.

[This sounds like no response, no field schedule.—Ed.]

BOOK REVIEWS

Chromosome Atlas of Flowering Plants. By C. D. Darlington and A. P. Wylie. xix–519 pages. George Allen & Unwin Ltd. 1956. 60s.

In 1945 the CHROMOSOME ATLAS OF CULTIVATED PLANTS by Darlington and Janaki Ammal was published. The present ATLAS, by Darlington and Wylie, is extended to cover the whole of the Flowering Plants. Chromosome counts of over 17,000 species are listed and there is a bibliography of about 3,000 references. This book is indispensable for the cytologist, the plant breeder and the systematic botanist. Quite properly it is dedicated to Nikolai Vavilov.—C. A. BERGER, Biological Laboratory, Fordham University. New York 58, N. Y.

Chromosome Botany. By C. D. Darlington. George Allen & Unwin Ltd. London, 1956. 186 pp. 16 s net.

The distinctive contribution of Professor Darlington to cytology has been his explanation of chromosome mechanisms on basis of simple physical laws. He is also known as a forceful and erudite writer of innumerable papers and books on modern cytogenetics, and it is indisputable that no single person has made a stronger influence on the development of cytology than he did with his two editions of the classical "Recent Advances in Cytology".

Although the works by Darlington have been limited to cytology, his interest in evolution has often led him to make statements concerning the impact of cytology upon systematics and ecology. Unfortunately, his experience in these fundamental fields has not been as thorough as in cytogenetics; consequently taxonomists and ecologists have not always taken his statements as seriously as they should have done.

The new book on "Chromosome Botany" expresses an expansion of these interests in other sciences, and the author himself states in the preface that the purpose of the book is to "make it possible to bring our knowledge of wild and cultivated plants, our knowledge of systematics and ecology into one focus". This is an ambitious objective, and certainly there will not be complete agreement upon the extent of his success. An indication of the ways in which he attempts to achieve this end may be seen in the mere listing of the headings of the chapters in the book: I. The chromosomes; II. Plants in groups; III. Plants in space; IV. Plants in time; V. Cultivated plants; VI. Ornamental plants; VII. The lessons of chromosome botany. Throughout these chapters the results of cytology are constantly referred to in a very illustrative way, while the taxonomical and ecological sciences receive a rather stepmotherly treatment.

Darlington's "Chromosome Botany" is as controversial as are all his books, and as convincingly learned and brilliantly written as could be expected. The arguments are largely original though not always thoroughly modern from the point of view of taxonomy and ecology, and the selection of references is unusually faulty and haphazard. The explanation sketches, particularly of complex phenomena, are as fully informative as we have come to expect from Professor Darlington. And, although it

must be said that the book is rather about chromosomes than botany, and that many of its statements perhaps shoot over the goal, it is nevertheless of such a high quality that any course in general botany, general cytogenetics, taxonomy or ecology, or even plant breeding, which does not consider his ideas, can hardly be regarded as modern botany.—ASKELL LÖVE, Institut Botanique de l'Université de Montréal.

Evolution, Genetics & Man. By Theodosius Dobzhansky. 398 pp. John Wiley & Sons, Inc. N.Y., N.Y. 1955. $5.50.

One of our greatest living geneticists presents us with a stimulating and effective textbook. It covers the broad field of Evolution and Genetics with special reference to man. In his preface the author modestly apologizes for having fallen short of his attempt to show "that biology is not only a craft which is interesting to technicians and devotees but also a part of the fabric of modern humanistic thought". It is doubtful if anyone else could have done as well. He writes out of his vast experience in the laboratory and the field in various parts of the world; he organizes his material with the facility of a scholar who has taken a real interest in his students and how best to teach them; he has original ideas and a flair for clothing them in effective phrases. He starts off with a crisp generalization or two. "The purpose of science is twofold. Science strives in the first place to understand man and the universe of which he is a part. In the second place, science endeavors to provide man with the means to control his environment. The quest for understanding is a function of theoretical, fundamental, or pure science. Knowledge and understanding are sources of satisfaction even when they do not yield any immediate material benefits. Control of the environment is a function of applied science or technology". Some 377 pages later after a brave attempt to wrestle honestly with such topics as EVOLUTIONARY ETHICS and the EQUALITY OF MAN he winds up his book by quoting Julian Huxley's analysis of man as business manager for the process of evolution and concludes "man does struggle against the bounds of his nature, and this struggle makes his existence worth while, and contains a hope of a noble future".

In between he has taken up clearly and concisely: elementary genetics, a good deal of cytology as it relates to the germplasm, Population Genetics, the Species Problem, Evolution under domestication, not only a full discussion of the Genetics of Sex determination but a broad discussion of the whole Evolution of sex, Organic Evolution, and Human Evolution and the Race problem with special reference to man. Eminent authorities who happen to disagree with Professor Dobzhansky are frequently cited, sometimes in considerable (and quite commendatory) detail. It is, you see, quite a package. It will be a generally useful text (or reference book) in many a university course which goes by the name of Genetics and Evolution, or Modern Evolutionary Thought or some such name. The publishers have cooperated by producing a well bound and attractively printed volume averaging one figure every three or four pages. The illustrations are effective, a number of them were prepared specially for this book; they too bespeak the scholar who through long experience has learned how to get his point across.

In personal conversation Professor Dobzhansky has sometimes chided scholars who, like this reviewer, cherish a Batesonian interest in those few significant facts which do not fit in easily with today's facile exposition of basic principles. At such times he cites an old Russian proverb, warning one against "making odd noises for the benefit of future generations." There are few such "odd noises" in this book. They are probably pretty much out of place in modern textbooks.—EDGAR ANDERSON.

Forest Seed Directory. Food and Agriculture Organization of the United Nations. Rome, Italy. 1955 xii + 158 pp. $1.00.

The importation of exotic tree seed for reforestation, research and teaching purposes has always presented difficulties that have discouraged a wider use of foreign species. This pertinent directory overcomes many of the problems by providing an ex-

tensive list of seed which is collated to a global list of seed dealers. An internationally standardized set of order and certification blanks is provided for the convenience of the purchaser.

The introduction and seed order forms are printed in English, French and Spanish while the text is in English. The directory is divided into three main sections: 1. the addresses of 165 seed suppliers from 101 nations or colonies; 2. a list of 725 genera and approximately 2320 species each of which is followed by one or more reference numbers which are cited to the addresses of the suppliers; and 3. a detailed description of 118 Eucalypt species indicating life zone temperatures and precipitation ranges plus the current availability of the seed for distribution.—JOHN W. ANDRESEN, Department of Forestry, College of Agriculture, Rutgers, the State University of New Jersey.

Drawings of British Plants. Part IX. Rosaceae (2). By Stella Ross-Craig. *pl. 1–39*, index. G. Bell and Sons Ltd., London. 26 July 1956. 8s. 6d. ($1.19).

In the words of the publisher: "the publication of Part IX of Miss Ross-Craig's magnum opus completes the third volume. We hope that you may consider this a suitable occasion for recording the steady progress towards completion of this very considerable undertaking." Earlier parts of the series have been noticed in the BULLETIN (see p. 82). In this part we find illustrations of *Agrimonia, Alchemilla, Aphanes, Poterium, Sanguisorba, Rosa, Sorbus, Crataegus, Pyrus, Malus, Mespilus,* and *Cotoneaster.* All but three of these include species which have established themselves in America; but, even aside from these, the beautifully illustrated diagnostic details must be of value to any one studying these genera.—H. W. RICKETT, The New York Botanical Garden.

Plants in Action: A Laboratory Manual of Plant Physiology. By Leonard Machlis and John G. Torrey, illustrated by Evan Gillespie. 288 pages, 64 illustrations. W. H. Freeman and Company. San Francisco. 1956. $3.75.

Everyone teaching a course in plant physiology may well consider this manual, no matter what manual or textbook is now in use. Students not using this manual will find it a helpful reference. Obviously it must cover the familiar topics of the science but there are many new and intriguing exercises. Subject matter that may have been avoided as complicated experimentally is made simple and understandable. This is accomplished through unusually complete instructions, complete chemical formulae, and Gillespie's drawings. There are 57 experiments with ample chance for careful observation, varied methods of recording results, and the drawing of conclusions from data. But the student is not left on his own. He is told the facts of each topic, "what it is all about," and then fully directed in his own investigation of some facet of the topic. Appendix 1, Electromagnetic Radiation, and Appendix 2, Determination of the Standard Deviation and the Standard Error, will be useful to the Student. Appendix 3, Information for Scheduling and Supplying the Laboratory, is just what every instructor wishes he had for each course offered. There is an index, followed by 120 pages of report forms. Paper covered, the manual may be easily broken up for a three-ring binder if desired.—JOHN A. SMALL, Douglass College, New Brunswick, N. J.

NOTE

For his monographic study of *Veratrum* and allied genera in the Liliaceae, Mr. James H. Zimmerman, Department of Botany, University of Wisconsin, Madison 6, Wisconsin, would be most grateful to receive material (live plants, picked flowers, or loans of pressed specimens) and information (observations in the field or studies of taxonomy, ecology, cytology) pertaining to species in the *Veratreae* from any part of the world.

BULLETIN OF THE TORREY BOTANICAL CLUB

VOL. 43, No. 6, pp. 443–456 DECEMBER, 1956

INDEX TO AMERICAN BOTANICAL LITERATURE

COMPILED BY

LAZELLA SCHWARTEN

WITH THE COLLABORATION OF THE EDITORS OF THE TAXONOMIC INDEX

TAXONOMY, PHYLOGENY AND FLORISTICS

ALGAE

(See also under Ecology: **Whitford**)

Blum, John L. The ecology of river algae. Bot. Rev. **22**: 291–341. My 1956.

Brunel, Jules. Addition du *Stephanodiscus binderanus* à la flore diatomique de l'Amérique du Nord. Nat. Canad. **83**: 89–95. My 1956.

Croasdale, Hannah. A correction in the names of two species of Heterokontae. Rhodora **58**: 161–167. Je [12 Jl] 1956.

Drouet, Francis & Daily, William A. Revision of the coccoid Myxophyceae. Butler Univ. Bot. Stud. **12**: 1–208. Je 1956.

Forest, Herman S. A study of the genera *Draparnaldia Bory* and *Draparnaldiopsis* Smith and Klyver. Castanea **21**: 1–29. Mr [Je] 1956.

Joly, Aylthon B. Additions to the marine flora of Brazil. I. Univ. S. Paulo Fac. Filos. Ci. Letr. Bol. Bot. **13**: 1–15. *pl. 1–3.* 1956.

Joly, Aylthon B. The sexual female plants of *Griffithsia tenuis* C. Agardh. Univ. S. Paulo Fac. Filos. Ci. Letr. Bol. Bot. **13**: 1–15. *pl. 1–3.* 1956.

Lingappa, B. T. *Synchytrium borreriae;* an endophytic alga. Mycologia **48**: 427–432. Je 1956.

Müller Melchers, F. C. *Biddulphia chinensis* Grev. as indicator of ocean currents. Com. Bot. Mus. Montevideo 2^{26}:1–14. *pl. 1–5.* 1952.

Whitford, L. A. Additions to the fresh-water algae in North Carolina I. Trans. Am. Micr. Soc. **75**: 196–203. Ap [Je] 1956.

BRYOPHYTES

Bryan, Virginia S. Cytological and taxonomic studies of some species of *Astomum, Acaulon* and *Phascum.* Bryologist **59**: 118–129. Je 1956.

Clark, Lois. *Frullania brachycarpa.* Bryologist **59**: 140–143. Je 1956.

Miller, W. E. & Ammons, Nelle. The genus *Mnium* in West Virginia. Castanea **21**: 63–72. Je 1956.

Pursell, Ronald A. New moss records for Centre and Huntington Counties, Pennsylvania. Bryologist **59**: 143–145. Je 1956.

Schuster, R. M. Notes on nearctic Hepaticae X. A study of *Cephaloziella rhizantha, C. floridae* and *C. ludoviciana.* Bryologist **59**: 130–140. Je 1956.

Van der Wijk, R. Plans for a new *Index Muscorum.* Bryologist **59**: 145, 146. Je 1956.

FUNGI

(See also under Algae: **Lingappa**; under Morphology; **Raper**)

Anderson, Edgar & Rudolph, E. D. An analysis of variation in a variable population of *Cladonia.* Evolution **10**: 147–156. Je 1956.

Cain, Roy F. & Hastings, Nancy A. Studies of soil fungi. II. A new species of *Sphaerospora* [*minuta*] with a *Botrytis*-like stage. Canad. Jour. Bot. **34**: 360–376. My 1956.

Carmichael, J. W. Frozen storage for stock cultures of fungi. Mycologia **48**: 378–381. Je 1956.

Cooke, Wm. Bridge. The genus *Phlebia* [7 sp. nov., 1 gen. nov.]. Mycologia **48**: 386–405. Je 1956.

Fuentes, C. A. *Microascus pedrosoi* is *M. cinereus*—a correction. Mycologia **48**: 446–448. Je 1956.

Gordon, Morris A. Occurrence of *Tricellula inaequalis* in tne United States. Mycologia **48**: 320–323. Mr-Ap [2 My] 1956.

Hale, Mason E. Fluorescence of lichen depsides and depsidones as a taxonomic criterion. Castanea **21**: 30–32. Mr [Je] 1956.

Hale, Mason E. Studies on the chemistry and distribution of North American lichens (6–9). Bryologist **59**: 114–117. Je 1956.

Hale, M. E. & Culberson, W. L. A checklist of the lichens of the United States, Canada and Alaska. Castanea **21**: 73–105. Je 1956.

Hirschhorn, Elisa. Ustilaginales de la flora Uruguaya. Com. Bot. Mus. Montevideo 2^{21}: 1–15. 12 D 1946.

Imshaug, Henry A. Catalogue of Central American lichens. Bryologist **59**: 69–114. Je 1956.

Johns, Robert M. Additions to the phycomycete flora of the Douglas Lake region. III. A new species of *Scherffeliomyces* [*leptorrhizus*]. Mycologia **48**: 433–438. Je 1956.

Karling, John S. Canadian species of *Synchytrium*. Canad. Jour. Bot. **34**: 406–416. My 1956.

Kennedy, Lorene L. *Dacrymyces palmatus*. Mycologia **48**: 311–319. Mr-Ap [2 My] 1956.

Leathers, Chester R. New species [4] and varieties [3] of *Clavaria* from Michigan. Mycologia **48**: 278–287. Mr-Ap [2 My] 1956.

Lowy, Bernard. A note on *Sirobasidium*. Mycologia **48**: 324–327. Mr-Ap [2 My] 1956.

Mains, E. B. The relationship of *Cudoniella* and *Helotium*. Mycologia **48**: 410–419. Je 1956.

Mishra, J. N. Ustilaginales of Bihar, I. Two new species. Mycologia **48**: 406–409. Je 1956.

Paterson, R. A. Additions to the phycomycete flora of the Douglas Lake region. II. New chytridiaceous fungi [2 sp. nov.]. Mycologia **48**: 270–277. Mr-Ap [2 My] 1956.

Singer, Rolf. Contributions towards a monograph of the genus *Pluteus*. Brit. Mycol. Soc. Trans. **39**: 145–232. Je 1956.

Skinner, C. E. & Huxley, M. Joan. *Rhodotorula glutinis*. Mycologia **48**: 371–377. Je 1956.

Snell, Walter H. & Dick, Esther A. Notes on boletes. IX. [3 sp. nov. of *Suillus*.] Mycologia **48**: 302–310. Mr-Ap [2 My] 1956.

Snell, Walter H. & Dick, Esther A. An unusual phalloid [*Pseudocolus shellenbergiae*] from Massachusetts. Mycologia **48**: 327. Mr-Ap [2 My] 1956.

Sprague, Roderick. Regarding *Corticium hiemalis* [sic] Laurila. Northw. Sci. **30**: 47. My 1956.

Townsend, G. Fred. A macro yeast cell. Trans. Am. Micr. Soc. **75**: 217, 218. Ap [Je] 1956.

Vanbreuseghem, R. *Histoplasma duboisii* and large forms of *Histoplasma capsulatum*. Mycologia **48**:264–269. Mr-Ap [2 My] 1956.

PTERIDOPHYTES

Copeland, Edwin B. *Ctenopteris* in America. Philipp. Jour. Sci. **84**: 381–494. *pl. 1–16.* D 1955.

Hagenah, Dale J. More hart's-tongue in Michigan. Am. Fern Jour. **46**: 70–74. Ap-Je [Jl] 1956.

Harley, Winifred J. Plants of the tree-trunks in Liberia. Am. Fern Jour. **46**: 65–69. Ap-Je [Jl] 1956.

Legrand, Diego. Las especies de *Dryopteris* del Uruguay. Com. Bot. Mus. Montevideo 2^{23}: 1–27. *pl. 1, 2.* 12 My 1952.

McGregor, Ronald L. & Hartman, Emily L. Notes on Kansas ferns. Am. Fern Jour. **46**: 84–87. Ap-Je [Jl] 1956.

Miller, Bert. A new locality for *Marsilea quadrifolia* L. Am. Fern Jour. **46**: 90, 91. Ap-Je [Jl] 1956.

Mohlenbrock, Robert H. An unusual form of *Asplenium pinnatifidum.* Am. Fern Jour. **46**: 91–93. Ap-Je [Jl] 1956.

Moore, John A. Notes on fern distribution in Louisiana. Am. Fern Jour. **46**: 82–84. Ap-Je [Jl] 1956.

Murillo, María Teresa. Contribución al conocimiento de los helechos de Colombia. Revista Acad. Colomb. **9**: 342–349. My 1956.

Reed, Clyde F. The family names of the lycosphens. Am. Fern Jour. **46**: 88–90. Ap-Je [Jl] 1956.

Smith, Dale M. A collection of *Asplenium montanum* in Indiana. Am. Fern Jour. **46**: 94, 95. Ap-Je [Jl] 1956.

Wagner, Warren H. *Asplenium ebenoides* × *platyneuron,* a new triploid hybrid produced under artificial conditions. Am. Fern Jour. **43**: 75–82. Ap-Je [Jl] 1956.

SPERMATOPHYTES

(See also under Morphology: **Dunn**)

Barneby, R. C. Pugillus *Astragalorum* XVIII: Miscellaneous novelties and reappraisals. Am. Midl. Nat. **55**: 477–503. XIX: Notes on *A. sericoleucus* Gray and its immediate relatives. 504–507. Ap 1956.

Barroso, G. M. Contribuição ao estudo das Compositae brasileiras. Arq. Jard. Bot. Rio de Janeiro **13**: 5–13. *pl. 1–7.* D 1954.

Bondar, Gregorio. Nova espécie de *Orbignya,* produtora do óleo de babaçú. Arq. Jard. Bot. Rio de Janeiro **13**: 55–59. *pl. 1–6.* D 1954.

Brade, A. C. Begonias novas do Brasil. VII. Arq. Jard. Bot. Rio de Janeiro **13**: 69–91. *pl. 1–12.* D 1954.

Brade, A. C. Contribuição para o conhecimento da flora da Serra do Itatiaia, Brasil. Arq. Jard. Bot. Rio de Janeiro **13**: 61–68. *pl. 1–5.* D 1954.

Brade, A. C. Espécies novasdo gènero *Polygala* do Brasil. Arq. Jard. Bot. Rio de Janeiro **13**: 15–27. *pl. 1–3.* D 1954.

Bravo Hollis, Helia. Algunas observaciones acerca de la vegetación de la región de Escárcega, Campeche, y zonas cercanas. An. Inst. Biol. [Mexico] **26**: 283–301. 20 Je 1956.

Brown, J. R. Notes on haworthias [*H. margaritifera*]. Cactus & Succ. Jour. **28**: 51–53. Ap 1956. [*H. cordifolia asperula.*] 76–78. My 1956.

Cárdenas, Martin. New Bolivian cacti—part 4 [*Cleistocactus* & *Echinopsis* spp. nov]. Cactus & Succ. Jour. **28**: 54–61. Ap 1956. 71–75. My 1956.

Carlquist, Sherwin. On the generic limits of *Eriophyllum* (Compositae) and related genera. Madroño **13**: 226–239. 20 Jl 1956.

Celarier, Robert P. Additional evidence for five as a basic chromosome number of the Andropogoneae. Rhodora **58**: 135–143. *pl. 1226.* Je [12 Jl] 1956.

Celarier, Robert P. A new species of *Tradescantia* (Commelinaceae) from south Texas. Field & Lab. **24**: 5–9. Ja [15 Je] 1956.

Chebataroff, Jorge. Algunas compuestas nuevas o poco conocidas de la flora uruguaya. Com. Bot. Mus. Montevideo **2**[19]: 1–9. 28 F 1946.

Cronquist, Arthur. Compositae. *In:* Hitchcock, C. L. *et al.* Vascular plants of the Pacific northwest. **5**: 1–343. 1955.

Cuatrecasas, José. Neue *Vernonia*-Arten und Synopsis der andinen Arten der Sektion *Critoniopsis.* Bot. Jahrb. **77**: 52–84. Ap 1956.

Cuatrecasas, José. Notas a la flora de Colombia, XIV. Revista Acad. Colomb. **9**: 325–341. My 1956.

Cuatrecasas, José. Studies in South American plants—IV. Brittonia **8**: 195–200. 16 Jl 1956.

Cuatrecasas, José. Studies on Andean Compositae—III. Brittonia **8**: 179–193. 16 Jl 1956.

Dugand, Armando. Plantae praesertim maypurenses a Humboldtio et Bonplandio in ripa occidentali fluminis Orinoco lectae ideoque ad floram colombiensem referendae. Revista Acad. Colomb. **9**: 315–324. My 1956.

Durán, Laura & Rosengurtt, Bernardo. Las flechillas de los géneros *Stipa* y *Piptochaetium* del Uruguay. Com. Bot. Mus. Montevideo **2**[29]:1–5. *pl. 1–9.* 10 F 1956.

Fosberg, F. R. Pacific forms of *Lepturus* R. Br. (Gramineae). Occ. Pap. Bishop Mus. **21**: 285–294. 29 Au 1955.

Fosberg, F. R. Studies in Pacific Rubiaceae: I–IV. Brittonia **8**: 165–178. 16 Jl 1956.

Freeman, Oliver M. New or noteworthy plants from Polk Co., North Carolina or vicinity. Castanea **21**: 41–43. Je 1956.

Garay, Leslie A. Contribution towards a monograph of the genus *Stelis* Sw. Canad. Jour. Bot. **34**: 346–359. My 1956.

Garay, Leslie A. Notatio orchidologica III. Arq. Jard. Bot. Rio de Janeiro **13**: 29–54. *pl. 1, 2.* D 1954.

Gould, Frank W. Chromosome counts and cytotaxonomic notes on grasses of the tribe Andropogoneae. Am. Jour. Bot. **43**: 395–404. Je [Jl] 1956.

Gunn, Charles R. A guide to some recent state floras. Castanea **21**: 33–38. Mr [Je] 1956.

Hardin, James W. Studies in the Hippocastanaceae II. Inflorescence structure and distribution of perfect flowers. Am. Jour. Bot. **43**: 418–424. Je [Jl] 1956.

Hodgson, H. J. A new *Elymus* [*pendulosus*] from Alaska. Rhodora **58**: 144–148. *pl.* [*1227*]. Je [12 Jl] 1956.

James, Charles W. A revision of *Rhexia* (Melastomataceae). Brittonia **8**: 201–230. 16 Jl 1956.

James, Robert Leslie. Introduced plants in northeast Tennessee. Castanea **21**: 44–52. Je 1956.

Johnston, Ivan M. Studies in the Boraginaceae, XXVIII. New or otherwise interesting species from America and Asia. Jour. Arnold Arb. **37**: 288–306. 16 Jl 1956.

Johnston, Marshall C. The Texas species of *Dyssodia* (Compositae). Field & Lab. **24**: 60–69. Ap [25 Jl] 1956.

Kruckeberg, A. R. Notes on the *Phacelia magellanica* complex in the Pacific northwest. Madroño **13**: 209–221. 20 Jl 1956.

Legrand, Diego. Algunas especies nuevas de *Portulaca*. Com. Bot. Mus. Montevideo 2^{22}: 1–5. *pl. 1–5*. 12 My 1952.

Legrand, Diego. Nota preliminar sobre las especies de *Myrceugenia* austrobrasilenas. Com. Bot. Mus. Montevideo. 2^{28}: 1–13. 24 D 1953.

Legrand, Diego. Notas sobre *Portulaca*. Com. Bot. Mus. Montevideo 2^{27}: 1–21. *pl. 1–6*. 24 D 1953.

Legrand, Diego. *Portulaca papaulifera* n. sp. y sus probables conecciones. Com. Bot. Mus. Montevideo 2^{20}: 1–10. 30 Mr 1946.

Legrand, Diego. Revisando tipos de *Portulaca*. Com. Bot. Mus. Montevideo 2^{24}: 1–10. *pl. 1, 2*. 12 My 1952.

Legrand, Diego. Sobre tres trabajos de Karl von Poellnitz sobre *Portulaca*. Com. Bot. Mus. Montevideo 2^{25}:1–9. 12 My 1952.

Lewis, Harlan & Roberts, Margaret R. The origin of *Clarkia lingulata*. Evolution **10**: 126–138. 30 Je 1956.

Long, Robert W. *Dentaria multifida* in central Ohio. Rhodora **58**: 160, 161. Je [12 Jl] 1956.

Martínez, Maximino. Los encinos de México. VI. An. Inst. Biol. [Mexico] **26**: 243–281. 20 Je 1956.

Mason, Herbert L. New species of *Elatine* [*heterandra*] in California. Madroño **13**: 239, 240. Jl 1956.

Matuda, Eizi. Las commelináceas mexicanas. An. Inst. Biol. [Mexico] **26**: 303–432. 20 Je 1956.

Moldenke, H. N. Materials toward a monograph of the genus *Vitex*. V. Phytologia **5**: 343–393. Je 1956.

Moldenke, H. N. Notes on new and noteworthy plants. XXI. Phytologia **5**: 338–342. Je 1956.

Muller, Cornelius H. The distribution of *Quercus boyntoni*. Madroño **13**: 221–225. 20 Jl 1956.

Nordenskiöld, Hedda. Cyto-taxonomical studies in the genus *Luzula*. II. Hybridization experiments in the *campestris-multiflora* complex. Hereditas **42**: 7–73. 15 My 1956.

Oswald, Fred W. A new color form of cornel from New Jersey. Phytologia **5**: 337, 338. Je 1956.

Rizzini, Carlos Toledo. Flora organensis. Lista preliminar dos Cormophyta da Serra dos Orgãos. Arq. Jard. Bot. Rio de Janeiro **13**: 115–243. *pl. 1–14*. D 1954.

Rollins, Reed C. Some new primitive Mexican Cruciferae. Rhodora **58**: 148–157. Je [12 Jl] 1956.

Ruschi, Augusto. Bromeliáceas novas do Est. do Espirito Santo. Bol. Mus. Biologia [Santa Teresa, Brazil] **15**: 1–3. 18 N 1954.

Ruschi, Augusto. Orchidáceas novas do Estado do Espirito Santo. Bol. Mus. Biologia [Santa Teresa, Brazil] **16**: 1–4. 28 D 1955.

Schultes, Richard Evans. Orchidaceae neotropicales I. De orchidaceis indigenis insularum Trinidad et Tobago notulae. Bot. Mus. Leafl. **17**: 179–209. *pl. 48–54*. 26 Je 1956.

Schultes, Richard Evans. The orchids of the island of Grenada, British West Indies. Am. Orchid Soc. Bull. **25**: 384–394. Je 1956.

Schweinfurth, Charles. Notes on Peruvian orchids. Bot. Mus. Leafl. **17**: 211–215. 26 Je 1956.

Shinners, Lloyd H. *Cenchrus parviceps* (Gramineae), a new species from southern Texas. Field & Lab. **24**: 73, 74. Ap [25 Jl] 1956.

Shinners, Lloyd H. *Elodea* correct without being conserved. Rhodora **58**: 162. Je [12 Jl] 1956.

Shinners, Lloyd H. *Physostegia serotina* (Labiatae), a new species from coastal Louisiana and Texas. Field & Lab. **24**: 17–19. Ja [15 Je] 1956.

Shinners, Lloyd H. Yellow-flowered *Oxalis* (Oxalidaceae) of eastern Texas and Louisiana. Field & Lab. **24**: 39, 40. Ja [15 Je] 1956.

Shinners, Lloyd H. *Zanthoxylon parvum* (Rutaceae), a new species from Trans-Pecos Texas. Field & Lab. **24**: 19, 20. Ja [15 Je] 1956.

Sleumer, H. Die Hieracien Argentiniens unter Berücksichtigung der Nachbarländer. Bot. Jahrb. **77**: 85–148. Ap 1956.

Smith, L. B. Notes on Bromeliaceae VII. Phytologia **5**: 394–400. Je 1956.

Steyermark, Julian A. & Swink, Floyd A. *Asclepias syriaca* var. *kansana* in New York state. Rhodora **58**: 197, 198. Jl 1956.

Tucker, John M. & Muller, Cornelius H. The geographic history of *Quercus ajoensis*. Evolution **10**: 157–175. Je 1956.

Turner, Billie L. A cytotaxonomic study of the genus *Hymenopappus* (Compositae). Rhodora **58**: 163–186. Jl 1956.

Turner, B. L. New names for Texas Leguminosae. Field & Lab. **24**: 15–17. Ja [15 Je] 1956.

Zielinski, Quentin B. *Escallonia:* the genus and its chromosomes. Bot. Gaz. **117**: 166–172. D 1955 [13 Je 1956].

PALEOBOTANY

(See also under Spermatophytes: **Tucker & Muller**)

Chaloner, W. G. On *Sporangiostrobus Langfordi* sp. nov., a new fossil lycopod cone from Illinois. Am. Midl. Nat. **55**: 437–442. Ap 1956.

Leclerq, S. Evidence of vascular plants in the Cambrian. Evolution **10**: 109–113. 30 Je 1956.

ECOLOGY AND PLANT GEOGRAPHY

Bell, Roger. Aquatic and marginal vegetation of strip mine waters in southern Illinois. Trans. Ill. Acad. **48**: 85–91. 1 Au 1956.

Boggess, W. R. Amount of throughfall and stemflow in a shortleaf pine plantation as related to rainfall in the open. Trans. Ill. Acad **48**: 55–61. 1 Au 1956.

Bormann, F. H. Percentage light readings, their intensity-duration aspects, and their significance in estimating photosynthesis. Ecology **37**: 473–476. Jl 1956.

Brewer, Richard & Triner, Edward D. Vegetational features of some strip-mined land in Perry County, Illinois. Trans. Ill. Acad. **48**: 73–84. 1 Au 1956.

Cottam, Grant & Curtis, J. T. The use of distance measures in phytosociological sampling. Ecology **37**: 451–460. Jl 1956.

Drury, William H. Bog flats and physiographic processes in the Upper Kuskokwim River region, Alaska. Contr. Gray Herb. **178**: 1–130. 16 Au 1956.

Ferri, Mario Guimarães. Contribuição ao conhecimento da ecologia do cerrado e da caatinga. Estudo comparativo da economia dágua de sua vegetação. Univ. S. Paulo Fac. Filos. Ci. Letr. Bol. Bot. **12**: 1–170. 1955.

Koller, Dov. Germination regulating mechanisms in some desert seeds III. *Calligonum comosum* L'Her. Ecology **37**: 430–433. Jl 1956.

Minckler, Leon S. Tree classes in the unmanaged forests of southern Illinois and application to forest management. Trans. Ill. Acad. **48**: 49–54. 1 Au 1956.

Potzger, John E. Pollen profile as indicators in the history of lake filling and bog formation. Ecology **37**: 476–486. Jl 1956.

Potzger, John E. & Courtemanche, Albert. Permafrost and some characteristics of bogs and vegetation of northern Quebec. Rev. Canad. Géogr. **9**: 109–114. 1955.

Rachid-Edwards, Mercedes. Alguns dispositivos para proteção de plantas contra a sêca e o fogo. Univ. S. Paulo Fac. Filos. Ci. Letr. Bol. Bot. **13**: 39–72. 1956.

Spurr, Stephen H. Natural restocking of forests following the 1938 hurricane in central New England. Ecology **37**: 443–451. Jl 1956.

Ward, Richard T. The beech forests of Wisconsin—Changes in forest composition and the nature of the beech border. Ecology **37**: 407–419. Jl 1956.

Whitford, L. A. The communities of algae in the springs and spring streams of Florida. Ecology **37**: 433–442. Jl 1956.

MORPHOLOGY

(including anatomy and cytology in part)

(See also under Spermatophytes: **Hardin**; under Genetics: **Shifriss**; under Plant Physiology: **Cantino**; **Cantino & Horenstein**)

Bailey, I. W. Nodal anatomy in retrospect. Jour. Arnold Arb. **37**: 269–287. 16 Jl 1956.

Bistis, George. Sexuality in *Ascobolus stercorarius*. I. Morphology of the ascogonium; plasmogamy; evidence for a sexual hormonal mechanism. Am. Jour. Bot. **43**: 389–394. Je [Jl] 1956.

Carlquist, Sherwin. On the occurrence of intercellular pectic warts in Compositae. Am. Jour. Bot. **43**: 425–429. Je [Jl] 1956.

Dunn, David B. The breeding systems of *Lupinus*, group *Micranthi*. Am. Midl. Nat. **55**: 443–472. Ap 1956.

Fisher, J. E. Floral inductions in soybeans. Bot. Gaz. **117**: 156–165. D 1955 [13 Je 1956].

Georg, Lucille K. Studies on *Trichophyton tonsurans*. II. Morphology and laboratory identification. Mycologia **48**: 354–370. Je 1956.

Kao, C. J. The cytology of *Xenogloea eriophori*. Mycologia **48**: 288–301. Mr-Ap [2 My] 1956.

Lee, C. L. Fertilization in *Ginkgo biloba*. Bot. Gaz. **117**: 79–100. D 1955 [13 Je 1956].

Mericle, Leo W., Eunus, Ali M. & Mericle, Rae Phelps. Effects of maleic hydrazide on embryologic development. I. *Avena sativa*. Bot. Gaz. **117**: 142–147. D 1955 [13 Je 1956].

Milanez, F. R. Origem das ramificações dos laticíferos do caule de *Euphorbia phosphorea* Mart. Arq. Jard. Bot. Rio. de Janeiro **13**: 93–114. *pl. 1–8*. D 1954.

Raper, Kenneth B. Factors affecting growth and differentiation in simple slime molds [2 sp. nov.]. Mycologia **48**: 169–205. Mr-Ap [2 My] 1956.

Russell, Norman H. Morphological variation in *Viola selkirkii* Pursh. Castanea **21**: 53–62. Je 1956.

Sen, J. Fine structure in degraded, ancient and buried wood, and other fossilized plant derivatives. Bot. Rev. **22**: 343–374. Je 1956.

Stokey, Alma G. & Atkinson, Lenette R. The gametophyte of the Osmundaceae. Phytomorphology **6**: 19–40. Mr 1956.

Venkatesh, C. S. The curious anther of *Bixa*—its structure and dehiscence. Am. Midl. Nat. **55**: 473–476. Ap 1956.

GENETICS
(including cytogenetics)

(See also under Phytopathology: **Greenleaf**; under Morphology: **Dunn**)

Davis, R. L. Tetrasomic inheritance of an elongated hypocotyl mutant in alfalfa. Agron. Jour. **48**: 197–199. My 1956.

Dermen, Haig. Histogenetic factors in color and fuzzless peach sports. Jour. Hered. **47**: 64–76. Mr-Ap [Je] 1956.

Dickson, A. G. & Samuels, Edmund W. The mechanism of controlled growth of dwarf apple trees. Jour. Arnold Arb. **27**: 307–313. 16 Jl 1956.

Ebersold, W. T. Crossing over in *Chlamydomonas reinhardi*. Am. Jour. Bot. **43**: 408–410. Je [Jl] 1956.

Eversole, Russell A. Biochemical mutants of *Chlamydomonas reinhardi*. Am. Jour. Bot. **43**: 404–407. Je [Jl] 1956.

Gopinath, D. M. & Burnham, C. R. A cytogenetic study in maize of deficiency-duplication produced by crossing interchanges involving the same chromosomes. Genetics **41**: 382–395. My [Je] 1956.

Hrushovetz, S. B. Cytological studies of *Helminthosporium sativum*. Canad. Jour. Bot. **34**: 321–327. *pl 1, 2*. My 1956.

Jinks, J. L. The F_2 and backcross generations from a set of diallel crosses [in *Nicotiana rustica*]. Heredity **10**: 1–30. 1956.

Jogi, B. S. The heritability of agronomic and disease reaction characteristics in two barley crosses. Agron. Jour. **48**: 293–296. Jl 1956.

Kamemoto, H. Cytology of *Vanda* Nellie Morley and *Vanda* Emma van Deventer. Am. Orchid Soc. Bull. **25**: 234–243. Ap 1956.

Kramer, H. H., Whistler, Roy L. & Anderson, E. G. A new gene interaction in the endosperm of maize. Agron. Jour. **48**: 170–172. Ap 1956.

Lepper, Robert. The plant centrosome and the centrosome-blepharoplast homology. Bot. Rev. **22**: 375–417. Je 1956.

Lima-de-Faria, A. The role of the kinetochore in chromosome organization. Hereditas **42**: 85–160. 15 My 1956.

Mitchell, Mary B. & Mitchell, Herschel K. Tests for non-allelism at the pyrimidine-3 locus of *Neurospora*. Genetics **41**: 319–326. My [Je] 1956.

Moh, C. C. & Nilan, R. A. Reduced gene transmission in radiator-induced mutant barley. Jour. Hered. **47**: 129–131. My-Je [Jl] 1956.

Nishiyama, Ichizo. Basic numbers in the polyploidy of *Saccharum*. Jour. Hered. **47**: 91–98. Mr-Ap [Je] 1956.

Pandey, K. K. Incompatibility in autotetraploid *Trifolium pratense*. Genetics **41**: 353–366. My [Je] 1956.

Pandey, K. K. Mutations of self-incompatibility alleles in *Trifolium pratense* and *T. repens*. Genetics **41**: 327–343. My [Je] 1956.

Penny, L. H. & Dicke, F. F. Inheritance of resistance in corn to leaf feeding of the European corn borer. Agron. Jour. **48**: 200–203. My 1956.

Shifriss, Oved. Sex instability in *Ricinus*. Genetics **41**: 265–280. Mr 1956.

Wimber, Donald E., Lenz, Lee W. & Dodson, Calaway. Further studies in intraclonal lip pattern variation in cymbidiums. Am. Orchid Soc. Bull. **25**: 153–158. Mr 1956.

Yeager, A. F. & Meader, E. M. A flesh-color chimera in the peach. Jour. Hered. **47**: 77, 78. Mr-Ap [Je] 1956.

Zirkle, Conway. L'affaire Lysenko: spring 1956. Jour. Hered. **47**: 47–54. Mr-Ap [Je] 1956.

PLANT PHYSIOLOGY

(See also under Morphology: **Bistis, Mericle**)

Akers, Thomas J. & Fang, S. C. Studies in plant metabolism. VI. Effect of 2, 4-D on the metabolism of aspartic acid and glutamic acid in the bean plant. Plant Physiol. **31**: 34–37. Ja [My] 1956.

Anderson, Irvin & Evans, Harold J. Effect of manganese and certain other metal cations on isocitric dehydrogenase and malic enzyme activities in *Phaseolus vulgaris*. Plant Physiol. **31**: 22–28. Ja [My] 1956.

Andreae, W. A. & Van Yseelstein, M. W. H. Studies on 3-indoleacetic acid metabolism, III. The uptake of 3-indoleacetic acid by pea epicotyls and its conversion to 3-indoleacetylaspartic acid. Plant Physiol. **31**: 235–240. My [Je] 1956.

Baker, James E., Gauch, Hugh G. & Dugger, W. M. Effects of boron on the water relations of higher plants. Plant Physiol. **31**: 89–94. Mr [Je] 1956.

Bernal, Daniel Mesa. El 2,3,5-trifenil, cloruro tetrasódico en la determinación de la germinabilidad de las semillas. Revista Acad. Colomb. **9**: 350–364. My 1956.

Biddulph, O., Cory, R. & Biddulph, S. The absorption and translocation of sulfur in red kidney bean. Plant Physiol. **31**: 28–33. Ja [My] 1956.

Bloodworth, M. E., Page, J. B. & Cowley, W. R. Some applications of the thermoelectric method for measuring water flow rates in plants. Agron. Jour. **48**: 222–228. My 1956.

Briggs, Winslow R. & Ray, Peter M. An auxin inactivation system involving tyrosinase. Plant Physiol. **31**: 165–167. Mr [Je] 1956.

Brock, Thomas D. Lipid synthesis in *Hansenula anomala*. Mycologia **48**: 337–344. Je 1956.

Buhler, D. R. *et al.* The conversion of $C^{14}O_2$ and CH_3-$C^{14}O$-COOH to citric and malic acids in the tomato fruits. Plant Physiol. **31**: 192–195. My [Je] 1956.

Bukovac, M. J., Wittwer, S. H. & Tukey, H. B. Anesthetization by di-ethyl ether and the transport of foliar applied radiocalcium. Plant Physiol. **31**: 254, 255. My [Je] 1956.

Butler, Edward E. Spore germination in *Sordaria fimicola*. Mycologia **48**: 345–348. Je 1956.

Cantino, Edward C. The relation between cellular metabolism and morphogenesis in *Blastocladiella*. Mycologia **48**: 225–240. Mr-Ap [2 My] 1956.

Cantino, Edward C. & Horenstein, E. A. Gamma and the cytoplasmic control of differentiation in *Blastocladiella*. Mycologia **48**: 443–446. Je 1956.

Collins, F. I. & Cartter, J. L. Variability in chemical composition of seed from different portions of the soybean plant. Agron. Jour. **48**: 216–219. My 1956.

DeRopp, R. S. Kinetin and auxin activity. Plant Physiol. **31**: 253, 254. My [Je] 1956.

Freiberg, S. R. Effects of growth-regulators on ripening, split peel, reducing sugars and diastatic activity of bananas. Bot. Gaz. **117**: 113–119. D 1955 [13 Je 1956].

Good, Norman E. *et al.* Studies on 3-indoleacetic acid metabolism. II. Some products of the metabolism of exogenous indoleacetic acid in plant tissues. Plant Physiol. **31**: 231–235. My [Je] 1956.

Gottlieb, David & Ciferri, Orio. Deamination and degradation of amino acids by streptomycetes. Mycologia **48**: 253–263. Mr-Ap [2 My] 1956.

Gowing, Donald P. An hypothesis of the role of naphthaleneacetic acid in flower induction in the pineapple. Am. Jour. Bot. **43**: 411–418. Je [Jl] 1956.

Grabe, Don F. Maturity [of seed in relation to germination] in smooth bromegrass. Agron. Jour. **48**: 253–256. Je 1956.

Hackett, David P. Pathways of oxidation in cell-free potato fractions. Plant Physiol. **31**: 111–118. Mr [Je] 1956.

Hacskaylo, Joseph & Ergyle, David R. Effect of schradan on growth and photosynthetic pigments of the cotton plant. Bot. Gaz. **117**: 120–126. D 1955 [13 Je 1956].

Hammar, Harald E. Effect of spray residues and other contaminants on leaf analysis. Plant Physiol. **31**: 256, 257. My [Je] 1956.

Hay, J. R. The effect of 2,4-dichlorophenoxyacetic acid and 2,3,5-triiodobenzoic acid on the transport of indoleacetic acid. Plant Physiol. **31**: 118–120. Mr [Je] 1956.

Helson, V. A. & Minshall, Wm. Harold. Effects of petroleum oils on the carbon dioxide output in respiration of parsnip and mustard. Plant Physiol. **31**: 5–11. Ja [My] 1956.

Hochstein, Paul E. & Cox, Carroll E. Studies on the fungicidal action of N-(trichloromethylthio)-4-cyclohexene-1,2-dicarboximide (captan). Am. Jour. Bot. **43**: 437–441. Je [Jl] 1956.

Honda, S. I. The salt respiration and phosphate contents of barley roots. Plant Physiol. **31**: 62-70. Ja [My] 1956.

Hopkins, H. T. Absorption of ionic species of orthophosphate by barley roots: effects of 2,4-dinitrophenol and oxygen tension. Plant Physiol. **31**: 155–161. Mr [Je] 1956.

Hunter, Norvell W. *et al.* Effects of light on the rate of respiration in the stem of *Pisum sativum* L. Plant Physiol. **31**: 167–169. Mr [Je] 1956.

Jacobson, Louis & Oertli, J. J. The relation between iron and chlorophyll contents in chlorotic sunflower leaves. Plant Physiol. **31**: 199–204. My [Je] 1956.

Johnson, S. P. & Hall, Wayne C. Further studies on vegetative and fruiting responses of tomatoes to high temperature and light intensity. Bot. Gaz. **117**: 100–113. D 1955 [13 Je 1956].

Kay, Robert E. & Phinney, Bernard. Plastid pigment changes in the early seedling leaves of *Zea mays* L. Plant Physiol. **31**: 226–231. My [Je] 1956.

Klein, Richard M. & Vogel, Howard H. Necessity of indoleacetic acid for the duplication of crown-gall tumor cells. Plant Physiol. **31**: 17–22. Ja [My] 1956.

Leggett, James E. & Epstein, Emanuel. Kinetics of sulfate absorption by barley roots. Plant Physiol. **31**: 222–226. My [Je] 1956.

Levitt, J. The physical nature of transpirational pull. Plant Physiol. **31**: 248–251. My [Je] 1956.

Lindner, R. C., Kirkpatrick, Hugh C. & Weeks, T. E. Free ribonucleic acid particles in homogenates of plant tissue. Plant Physiol. **31**: 1–4. Ja [My] 1956.

Liverman, James L. & Lang, Anton. Induction of flowering in long day plants by applied indoleacetic acid. Plant Physiol. **31**: 147–150. Mr [Je] 1956.

Lowry, R. J., Sussman, A. S. & Heidenhain, Berta. Lysozyme-induced sensitivity of *Neurospora* ascospores to furfural. Mycologia **48**: 241–252. Mr-Ap [2 My] 1956.

McIlrath, Wayne J. Lipase activity in cotton seedlings. Trans. Ill. Acad. **48**: 42–48. 1 Au 1956.

Marvin, James W. & Erickson, Ralph O. A statistical evaluation of some of the factors responsible for the flow of sap from the sugar maple. Plant Physiol. **31**: 57–61. Ja [My] 1956.

Mazelis, Mendal. Particulate adenylic kinase in higher plants. Plant Physiol. **31**: 37–43. Ja [My] 1956.

Miller, Gene W. & Thorne, D. Wynne. Effect of bicarbonate ion on the respiration of excised roots. Plant Physiol. **31**: 151–155. Mr [Je] 1956.

Muzik, T. J. & Cruzado, H. J. Effect of maleic hydrazide on pineapple. Plant Physiol. **31**: 81. Ja [My] 1956.

Nakata, Shigeru. Floral initiation and fruit set in lychee, with special reference to the effect of sodium napthaleneacetate. Bot. Gaz. **117**: 126–134. D 1955 [13 Je 1956].

Nitsch, J. P. & Nitsch, Colette. Studies on the growth of coleoptile and first internode sections. A new, sensitive, straight-growth test for auxin. Plant Physiol. **31**: 94–111. Mr [Je] 1956.

Ordin, Lawrence, Applewhite, Thomas H. & Bonner, James. Auxin-induced water uptake by *Avena* coleoptile sections. Plant Physiol. **31**: 44–53. Ja [My] 1956.

Ordin, Lawrence & Bonner, James. Permeability of *Avena* coleoptile sections to water measured by diffusion of deuterium hydroxide. Plant Physiol. **31**: 53–57. Ja [My] 1956.

Page, Robert M. Studies on the development of asexual reproductive structures in *Pilobolus*. Mycologia **48**: 206–224. Mr-Ap [2 My] 1956.

Reisner, Gerald S. & Thompson, John E. The large scale laboratory culture of *Chlorella* under conditions of micronutrient deficiency. Plant Physiol. **31**: 181–185. My [Je] 1956.

Ringel, Samuel M. & Beneke, E. S. The influence of certain sugars on the antifungal activity of sodium pyridinethione. Mycologia **48**: 329–336. Je 1956.

Rohrbaugh, Lawrence M. & Rice, Elroy L. Relation of phosphorus nutrition to the translocation of 2,4-dichlorophenoxyacetic acid in tomato plants. Plant Physiol. **31**: 196–199. My [Je] 1956.

Sachs, Roy M. Floral initiation in *Cestrum nocturnum*. I. A long-short day plant. Plant Physiol. **31**: 185–192. My [Je] 1956.

Salisbury, Frank B. & Bonner, James. The reactions of the photoinductive dark period. Plant Physiol. **31**: 141–147. Mr [Je] 1956.

Schieferstein, R. M. & Loomis, W. E. Wax deposits on leaf surfaces. Plant Physiol. **31**: 240–247. My [Je] 1956.

Shaw, Michael & Samborski, D. J. The physiology of host-parasite relations. I. The accumulation of radioactive substances at infections of facultative and obligate parasites including tobacco mosaic virus. Canad. Jour. Bot. **34**: 389–405. *pl. 1–8*. 1956.

Sideris, C. P. & Young, H. Y. Pineapple chlorosis in relation to iron and nitrogen. Plant Physiol. **31**: 211–222. My [Je] 1956.

Sims, Asa C. Factors affecting basidiospore develpoment of *Penllicularia filamentosa*. Phytopathology **46**: 471, 472. S 1956.

Sisler, Edward C., Dugger, W. M. & Gauch, Hugh C. The role of boron in the translocation of organic compounds in plants. Plant Phsyiol. **31**: 11–17. Je 1956.

Skok, John & Scully, Norbert J. Nature of the photoperiodic responses of buckwheat. Bot. Gaz. **117**: 134–141. D 1955 [13 Je 1956].

Snyder, Freeman W. Growth of excised tissues from the stem of *Cryptostegia grandiflora*. Bot. Gaz. **117**: 147–152. D 1955 [13 Je 1956].

Spencer, J. L., Morris, M. P. & Kennard, W. C. Vitamin C concentration in developing and mature fruits of mango (*Mangifera indica* L.). Plant Physiol. **31**: 79, 80. Ja [My] 1956.

Stafford, Helen A. Dehydrogenase activity of hydroxymalonate and related acids in higher plants. Plant Physiol. **31**: 135–141. Mr [Je] 1956.

Stone, Edward C., Shachori, Ami Y. & Stanley, Robert G. Water absorption by needles of ponderosa pine seedlings and its internal redistribution. Plant Physiol. **31**: 120–126. Mr [Je] 1956.

Stowe, Bruce B. *et al.* Further studies of some plant indoles and auxins by paper chromatography. Plant Physiol. **31**: 162–165. Mr [Je] 1956.

Sussman, A. S., Distler, J. R. & Krakow, J. S. Metabolic aspects of *Neurospora* activation and germination. Plant Physiol. **31**: 126–135. Mr [Je] 1956.

Tanada, T. Effect of ribonuclease on salt absorption by excised mung bean roots. Plant Physiol. **31**: 251–253 My [Je] 1956.

Troyer, James R. Quantitative changes in buckwheat flavonoid substances during seedling devlopment. Plant Physiol. **31**: 75–78. Ja [My] 1956.

Troyer, James R. Quantitative determination of buckwheat flavonoid substances by direct absorptiometry of paper chromatograms. Plant Physiol. **31**: 71–74. Ja [My] 1956.

Ulrich, Albert & Ohki, Kenneth. Chlorine, bromine and sodium as nutrients for sugar beet plants. Plant Physiol. **31**: 171–181. My [Je] 1956.

Vaartaja, O. Photoperiodic response in germination of seed of certain trees. Canad. Jour. Bot. **34**: 377–388. My 1956.

Voth, Paul D. Demonstrating mineral-nutrient deficiencies with *Regnellidium diphyllum*. Trans. Ill. Acad. **48**: 37–41. 1 Au 1956.

Wheeler, H. E. Sexual versus asexual reproduction in *Glomerella*. Mycologia **48**: 349–353. Je 1956.

Williams, W. A. Evaluation of the emergence force exerted by seedlings of small seeded legumes using probit analysis. Agron. Jour. **48**: 273, 274. Je 1956.

Young, L. C. T. & Conn, Eric E. The reduction and oxidation of glutathione by plant mitochondria. Plant Physiol. **31**: 205–211. My [Je] 1956.

PHYTOPATHOLOGY

(See also under Plant Physiology: **Hochstein & Cox; Shaw & Samborski**)

Arny, D. C. & Leben, Curt. Effect of storage on the fungicide content of oat seed treated with mercury compounds. Phytopathology **46**: 342–344. Je 1956.

Arny, D. C. & Leben, Curt. Control of several small grain diseases by the water-soak seed treatment. Phytopathology **46**: 344, 345. Je 1956.

Baker, Kenneth F. & Durbin, Richard D. Control of *Pythium* root rot of *Aloe variegata* by hot-water treatment. Cactus & Succ. Jour. **28**: 45, 46. Ap 1956.

Blackmon, Cyril & Mefferd, Roy B. *Sphacelotheca cruenta* 2. Growth characteristics in synthetic media and oxidative metabolism. Phytopathology **46**: 403–407. Jl 1956.

Baxter, J. W. *Cercospora* black stem of alfalfa. Phytopathology **46**: 398–402. Jl 1956.

Castano, J. J. & Kernkamp, M. F. The influence of certain plant nutrients on infection of soybeans by *Rhizoctonia solani*. Phytopathology **46**: 326–328. Je 1956.

Dale, J. L. & Thornberry, H. H. Influence of washing time on infection by tobacco mosaic virus. Trans. Ill. Acad. **48**: 62–65. 1 Au 1956.

Durbin, Richard D., Davis, Lily H. & Baker, Kenneth F. A *Helminthosporium* stem rot of cacti. Cactus & Succ. Jour. **28**: 46–49. Ap 1956.

Faull, J. H. A rust on *Woodwardia fimbriata*. Jour. Arnold Arb. **37**: 314–316. 16 Jl 1956.

Greenleaf, W. H. Inheritance of resistance to tobacco-etch virus in *Capsicum frutescens* and in *Capsicum annuum*. Phytopathology **46**: 371–375. Jl 1956.

Holton, C. S. *et al.* The reaction of varieties and hybrid selections of wheat to physiologic races of *Tilletia caries* and *T. foetida*. Agron. Jour. **48**: 276–278. Je 1956.

Hooker, A. L. Association of resistance to several seedling, root, stalk, and ear diseases in corn. Phtopathology **46**: 379–384. Jl 1956.

Kiesling, R. L. & Grafius, J. E. Several oat varieties resistant to natural infection by *Leptosphaeria avenaria*. Phytopathology **46**: 305, 306. Je 1956.

Le Tourneau, Duane. Catalase activity of seedling wheat leaves infected with stem rust. Bot. Gaz. **117**: 153–156. D 1955 [13 Je 1956].

Leben, Curt, Tsao, Peter H. & Keitt, G. W. A small-scale field test for evaluating fungicides. Phytopathology **46**: 333–335. Je 1956.

Lownsbery, B. F. *Pratylenchus vulnus*, primary cause of the root-lesion disease of walnuts. Phytopathology **46**: 376–379. Jl 1956.

Moseman, J. G. Physiological races of *Erysiphe graminis* f. sp. *hordei* in North America. Phytopathology **46**: 318–322. Je 1956.

Murray, Hazel C. & Zscheile, F. P. Studies on the amino acid composition and nutrient requirements of the wheat bunt fungus. Phytopathology **46**: 363–366. Jl 1956.

Olson, Edward O. Mild and severe strains of tristeza in Texas citrus. Phytopathology **46**: 336–341. Je 1956.

Plakidas, A. G. *Cercospora* leaf spot of *Abelia*. Mycologia **48**: 382–385. Je 1956.

Pramer, D., Robison, R. S. & Starkey, R. L. The mode of action of antibiotics in the control of plant disease. Phytopathology **46**: 341, 342. Je 1956.

Purdy, Lawrence H. & Holton, C. S. Vapor action of fungicides used in the control of wheat bunt. Phytopathology **46**: 385–387. Jl 1956.

Schwinghamer, E. A. Physiologic specialization in *Colletotrichum linicolum*. Phytopathology **46**: 300–305. Je 1956.

Shepherd, Robert J. & Struble, F. Ben. Tobacco ringspot virus on watermelon. Phytopathology **46**: 358–362. Jl 1956.

Sinclair, J. B. & Walker, J. C. Extent of cross protection among strains of cucumber mosaic virus in cucumber and cowpea. Phytopathology **46**: 367–371. Jl 1956.

Sinski, James T. Abortion reactions to infection by *Synchytrium brownii*. Mycologia **48**: 420–426. Je 1956.

Smalley, Eugene B. The production on garlic by an eriophyid mite of symptoms like those produced by viruses. Phytopathology **46**: 346, 347. Je 1956.

Vaartaja, Olli. Screening fungicides for controlling damping-off of tree seedlings. Phytopathology **46**: 387–390. Jl 1956.

Van Arsdal, E. P., Riker, A. J. & Patton, R. E. The effects of temperature and moisture on the spread of white pine blister rust. Phytopathology **46**: 307–318. Je 1956.

Wallace, J. M. *et al.* The tristeza virus in Israel. Phytopathology **46**: 347. Je 1956.

GENERAL BOTANY
(including Biography)

Alain, Frère. Frère. Léon (Joseph Sylvestre Sauget) 1871–1955. Taxon. **5**: 125–130. Au 1956.

Bean, Ralph C. Clarence Hinckley Knowlton. Rhodora **58**: 157–160. Je [12 Jl] 1956.

Courtemanche, Albert. John E. Potzger; Presque Isle (Michigan) 1886—Indianapolis (Indiana) 1955. Rev. Canad. Géogr. **9**: 207–210. 1955.

Ewan, Joseph. Humboldt and American botany. Rhodora **58**: 191–197. Jl 1956.

Geiser, S. W. Theodor Hielscher, early Texan naturalist. Field & Lab. **24**: 69–73. Ap [25 Jl] 1956.

Geiser, S. W. Thomas Nuttall's botanical collecting trip to the Red River, 1819. Field & Lab. **24**: 43–60. Ap [25 Jl] 1956.

Howard, Richard A. Elmer Drew Merrill 1876–1956. Jour. Arnold Arb. **37**: 197–216. *port.* 16 Jl 1956.

Klimstra, W. D. Problems in the use of *multiflora* rose. Trans. Ill. Acad. **48**: 66–72. 1 Au 1956.

Koch, Leo Francis & Crum, Howard A. Hedwig's *Species Muscorum* and its effective date of publication. Taxon **5**: 130–133. Au 1956.

Lange, Erwin F. Pioneer botanists of the Pacific Northwest. Oregon Hist. Quart. **57**: 108–124. Je 1956.

Mevins, Allan [*ed.*]. Narratives of exploration and adventure by John Charles Frémont. *i–v*, 1–532. *map.* 1956.

Peterson, L. C. & Welch, D. S. Donald Reddick, 1883–1955. Phytopathology **46**: 299. Je 1956.

Rollins, Reed C. A directory of specialists. Taxon **5**: 117–120. Au 1956.

Rollins, Reed C. Elmer Drew Merrill, adminstrator and botanist. Science **123**: 831, 832. 11 My 1956.

INDEX TO VOLUME 83

Names of contributors are printed in CAPITALS. Names of new genera, species, varieties, forms and combinations are printed in **bold face.** Numbers in *italic* refer to pages on which the name is listed as a synonym. Numbers in **bold face** refer to pages on which the name is accompanied by a description or illustration.

Abrus precatorius, 283
Acer, 209; *Negundo*, 209; *rubrum*, 383; *saccharum*, 209, 210, 215, 264
Acrocomia, 306
ADELSON, LIONEL M.: Spectrophotometric studies of *Polyporus cinnabarinus* and *Polyporus sanguineus*, 136
Adesmia punctata, 295
Adiantum pedatum, 438
Aeginetia, 167, 168, 169; *indica*, 167, 168
Aegopogon, 232
Aeschynomene, 233; *abyssinica*, 233
Aesculus, 209
Agrostema, 151
Agrostemma, 151
Agrostis, 264, 336
AHMAD, K.: A comparative study of the effect of corn (*Zea Mays*) steep liquor Bengal gram (Chick pea or *Cicer arietinum*) steep liquor and rice (*Oryza sativa*) steep liquor on the production of penicillin on surface culture, 30
Aira caryophyllea, 336
Alnus glutinosa, 383
Aloe, 370
Alopecurus, 336; *aequalis*, 336; *pratensis*, 336
Anacharis, 362, 368
ANDERSON, EDGAR: (Review), 441
ANDRESEN, JOHN W.: Bartram oak in New Brunswick, New Jersey, 171; (Review), 312; A large swamp white oak of the lower Raritan flood plain, 382; (Review), 441
Andropogon, 183, 190, 191; *distachyum*, 183; *distachyus*, 183, 184, 185, 188, 190, 191; *Gerardi*, 172
Angiopsora, 222; **africana**, **221**; **aurea**, **221**; *clemensiae*, 221; *compressa*, 221; **digitariae**, 221, **222**; *hansfordii*, 221; *phakopsoroides*, 221
Anthoxanthum, 433, 434; *odoratum*, 336
Aphanochaete, 147
Aralia nudicaulis, 172
Aristida oligantha, 172
Arrhenatherum elatius, 336
Asclepias sullivantii, 345
Ascobolus, 35, 55; *furfuraceus*, 55; *stercorarius*, 35, 39, 55, 56, 59
Aseptic studies on metabolism of nitrogenous compounds in plants, 421
Asimina triloba, 209
Aspergillus, 94
Asplenium, 274, 438; *platyneuron*, 438; *trichomanes*, 438
Aster macrophyllus, 172
Astrebla, 232
Athyrium, 438; *filix-femina*, 438; *thelypterioides*, 438; *thelypterioides* f. *acrostichoides*, 438
Avena, 336, 421, 423, 426; *fatua*, 336
Bacillus, 333; *subtilis*, 31
BACKUS, M. P.: Cytological studies on *Penicillium chrysogenum* Thom., 93
BAILEY, PAUL C.: Some notes on the influence of various buffer salts upon the rate of mitosis in root tips of *Trillium sessile* L., 410
Baptisia tinctoria, 173
Bartram oak in New Brunswick, New Jersey, 171
Bassia, 172; *hyssopifolia*, 172
Beckmannia, 336; *syzigachne*, 336
BERGER, C. A.: The cytology of *Xanthisma texanum* D.C. IV. Megasporogenesis and embryo sac formation, pollen mitosis and embryo formation, 428; (Review), 440
Betula, 209; *nigra*, 383
Bewsia biflora, 226
Biological transmission of plant viruses by insect vectors, 234
BISTIS, GEORGE: Studies on the genetics of *Ascobolus stercorarius*, 35
BLASDELL, ROBERT F.: A comparative study of Hawaiian species of the fern genus *Doodia*, 62
Blastocladiella, 220
Bombardia lunata, 47, 59
Bombax angulicarpum, 283
Book Reviews, 78, 173, 237, 310, 386, 440, 441, 442
Botanical bibliographies: classification, form, arrangement and use, 377
Botanical literature, Index to American, 84, 174, 241, 315, 391, 443
Botanical terms, Material for a dictionary of, IV, 342

Botrychium, 262, 264, 270, 272, 275, 436; *daucifolium*, 275; *dissectum*, 436; *dissectum* f. *elongatum*, 436; *dissectum* f. *oneidense*, 437; *lanceolatum* subsp. *angustisegmentum*, 278; *lanuginosum*, 275; *lunaria*, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 369; *lunaria* f. *gracile*, 263; *lunaria* f. *onondagense*, 261, 264; *lunaria* var. *typicum*, 263; *matricariaefolium*, 263, 264, 275, 276, 278, 437; *matricariaefolium* subsp. *hesperium; minganense*, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279; *multifidum*, 264, 265, 278; *multifidum* subsp. *californicum*, 278; *multifidum* subsp. *coulteri*, 278; *multifidum* var. *intermedium*, 437; *onondagense*, 261, 262, 263; *simplex*, 265, 274, 277, 278; *simplex* var. *compositum* 277; *simplex* var. *tenebrosum*, 263; *virginianum*, 264, 437

BOYDEN, ALAN: (Review), 81

Brachiaria brizantha, 221; *decumbens*, 221, 229

BROTHER LEON (JOSEPH SYLVESTRE SAUGET): (Obituary), 305

BUELL, MURRAY F.: *Sporobolus cryptandrus* (Torr.) A. Gray in the New Jersey Pine Barrens, 439

BURKHOLDER, PAUL B.: Studies on the nutritive value of *Spartina* grass growing in the marsh areas of coastal Georgia, 327

BUTLER, ELMER G.: Biological specificity and growth (Review), 80

Caespitella, 142, 144; *Pascheri*, 143, 147

Calamagrostis, 336

Caltha palustris, 345

Calyptrogyne, 306

CAMPBELL, T. H.: Cytological studies on *Penicillium chrysogenum* Thom., 93

Camptosorus, 438; *rhizophyllus*, 438

Cantharellus cinnabarinus, 139

Carya, 209, 211, 215; *illinoensis*, 209

Cassia fasciculata, 173

Castanea dentata, 78

CELARIER, ROBERT P.: Cytology of *Andropogon distachyus* L., 183

Celtis occidentalis, 209, 210, 215

Cercis canadensis, 209

Chaetophora, 141, 142, 145, 146, 147, 149

Cheilanthes, 438; *lanosa*, 438

Chemical strains of the *Parmelia Conspersa-Stenophylla* group in South Central United States, 218

Chlamydomonas, 146

Chloris, 232

Chlorosarcina, 142

Chlorosphaera, 142, 146

Christisonia albida, 168

Chromocrea spinulosa, 59

Chrysopogon, 229

Cicer arietinum, 30

Cicuta, 297; *douglasii*, 296; *mackenzieana*, 296

Cinna, 336; *arundinacea*, 336; *latifolia*, 336

Cissus quadrangularis, 283

Cistanche, 167, 169; *tinctoria*, 157

Classification and relationships of *Cucurbita mixta*, Pang., 253

Claytonia megarrhiza, 295; *virginica*, 296

Clematis ochreleuca, 385

Coccothrinax, 306

Comarium palustre, 298

Combretum micranthum, 283; *tomentosum*, 283

Commelina, 107, 108, 109, 110, 111; *benghalensis*, 110; *coelestis*, 110; *communis*, 110; *crispa*, 107; *erecta*, 107; *erecta* var. *crispa fide*, 107; *hirtella*, 110; *nudiflora*, 110

Commelinantia, 107, 108, 109, 110, 111; *anomale*, 107, 108, 109, 110, 111; *pringlei*, 107, 108, 109, 111

Commelinantia (*Commelineae*): An evaluation of its generic status, 107

Conferva, 141

Coniselinum, 297; *chinensis*, 296

CONNORS, CHARLES H.: (Review), 173, 237

Copernicia, 306, 309, 310; *cerifera*, 309

Cornus, 209

Corynebacterium michiganense, 139

Corynephorus canescens, 336

Crataegus, 209

CRONQUIST, ARTHUR: (Review), 238; Vascular plants of the Pacific Northwest (Review), 310

Cucurbita, 254, 256, 259; *argyrosperma*, 253; *ficifolia*, 256, 259; *maxima*, 253, 256, 257, 258, 259; *mixta*, 253, 254, 255, 256, 257, 258; *mixta cyanoperizona*, 253; *mixta stenosperma*, 253; *moschata*, 253, 256, 257, 258, 259; *pepo*, 256, 257, 259

CUMMINS, GEORGE B.: Description of tropical rusts—VIII, 221

CURTIS, J. T.: Plant ecology workbook (Review), 390

CUTLER, HUGH C.: *Cucurbita mixta* Pang. Its classification and relationships, 253

Cyperus filculmis var. *macilentus*, 439

Cystopteris, 274, 437; *dickieana*, 264; *fragilis*, 437
Cytological studies on *Penicillium chrysogenum*, 93
Cytology of *Andropogon distachyus*, 183
Dactyloctenium, 232
DANSEREAU, PIERRE: Studies in Potentillae of high latitudes and altitudes. II. Central Baffin Island populations, 113
Danthonia spicata, 336
DARLINGTON, C. D.: Chromosome atlas of flowering plants (Review), 440; Chromosome botany (Review), 440
Datura, 27, 29
Dennstaedtia, 438; *punctilobula*, 438
Deschampsia caespitosa, 336; *flexuosa*, 439
Desmodium perplexum, 173
Dichapetalum Spruceanum, 338
Dicheirinia, 223
Dictionary of botanical terms—IV. Terms to describe apices, 342
Digitaria chinensis, 222; *formosanum*, 222
Dionoea muscipula, 78
Diorchidium (*Puccinia*) *brachiariae*, 228
Distichlis, 3, 4
DOBZHANSKY, THEODOSIUS: Evolution, Genetics and Man (Review), 441
Doodia, 62, 65; *caudata*, 65; *kunthiana*, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71; *lyoni*, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71; *media*, 65
DORE, WILLIAM G.: Some grass genera with liquid endosperm, 335
Dothidea collecta, 409
Draparnaldia, 142, 143, 145, 146, 147, 148, 149; *acuta*, 145; *glomerata*, 145; *Macrocladia*, 145; *mutabilis*, 145; *mutabilis* f. *infantilis*, 145; *mutabilis* f. *opposita*, 145, 146; *plumosa*, 145
DRECHSLER, CHARLES: Production of zoospores from germinating oospores of *Pythium mamillatum* Meurs, 196
Dryopteris, 274, 437; *boottii*, 437; *cristata*, 437; *cristata* var. *Clintoniana*, 437; *goldiana*, 437; *hexagonoptera*, 437; *marginalis*, 437; *noveboracensis*, 437; *phegopteris*, 437; *spinulosa*, 437; *thelyteris*, 438
DUMAN, MAXIMILIAN G.: Three new North American varieties of *Kobresia*, 192
DUSTAN, ALICE L.: Landscaping your own home (Review), 237
Echites caudata, 286
Elyna, 192
Elyonurus, 190
Embryology of *Striga orobanchoides* Benth. and *Striga euphrasioides* Benth., a contribution to, 154
Entocladia, 143
Epiphyllous flowers, 338
Equisetum, 436; *arvense*, 436; *arvense* f. *ramulosum*, 436; *fluviatile*, 436; *hyemale* var. *affine*, 436; *scirpoides*, 436; *sylvaticum* var. *Pauciramosum* f. *multiramosum*, 436
Eragrostis capillaris, 173
Escherichia, 333; *coli*, 331
Eu-Andropogon, 190, 191
Eubotrychium, 265
Eupatorium serotinum, 172; *sessilifolium*, 173
Euphorbia cyparissias, 264; *nivulia*, 154
EVANS, RICHARD I.: (Review), 311
Evolution in the isogamous, filamentous chlorophyceae and their relation to the classification of the chlorophyceae, 141
FEELEY, E. J.: The cytology of *Xanthisma texanum* D.C. IV. Megasporogenesis and embryo sac formation, pollen mitosis and embryo formation, 428
FELL, EGBERT W.: Flora of Winnebago County, Illinois (Review), 313
Field trip reports, 78, 172, 385, 439
Fijian species of *Peperomia*, 300
FOREST, H. S.: Some aspects in the isogamous, filamentous Chlorophyceae and their relation to the classification of the Chlorophyceae, 141
Forest seed directory (Review), 441
FOSBERG, F. R.: (Review), 79
Fraxinus, 209, 210, 215; *Fraxinus americana*, 209, 383; *quadrangulata*, 209
Frommea, 224
Gaylussacia baccata, 172
Geminella, 146, 147, 149
Generic names *Lysichiton* and *Lysichitum*, a comment on, 151
Generic status of *Commelinantia*, an evaluation, 107
Gentiana autumnalis, 78
Geometrical aspects of cell shape, 355
Gerardia flava, 173
GILKEY, HELEN M.: (Review), 310
Ginkgo biloba, 308
Gleditsia triacanthos, 209, 383
Gonypetalum tessmannii, 338, 339
GOOD, DOROTHY: Geography of the Northlands (Review), 78
Grass genera with liquid endosperm, 335
GRESSITT, J. LINSLEY: Insects of *Micronesia* (Review), 79
Gymnocladus dioica, 209

HALE, JR. MASON E.: Chemical strains of the *Parmelia Conspersa-Stenophylla* group in South Central United States, 218
Hapalophragmium **deightonii, 222,** 224; *millettiae,* 222; *millettiae-rhodanthae,* 222
Harveya, 168
HAUPT, A. W.: An introduction to botany (Review), 312
HEISER, JR., CHARLES B.: (Review), 83
Helianthemum canadense, 173
Helianthus divaricatus, 173
Helictotrichcon, 336; *hookeri,* 335; *pratense,* 335
Helwingia japonica, 341
Hemithrinax, 306
Hieracium, 354
Hierochloë odorata, 336
HIRES, CLARA S.: Tetrad analysis through sectioned models, 72
Holcus, 336; *lanatus,* 336
Hosts and species of *Physoderma,* 292
HOWELL, D. L.: Composition of pre-settlement forests in three counties of Missouri, 207
Hudsonia tomentosa, 385
HULTEN, ERIC: A comment on the generic names of *Lysichiton* and *Lysichitum,* 151
HUTTLESTON, DONALD G.: (Review), 82
Hymenocarpus, 151
Hyobanche, 168
Hyparrhenia hirta, 227; *rufa,* 226
Hypericum, 265
Index to American botanical literature, 84, 174, 241, 315, 391, 443
ILTIS, HUGH H.: (Review), 314
Ipomoea panaurata, 78
Ischaemum ciliare, 222
ISLAM, M. F.: A comparative study of the effect of corn (*Zea mays*) steep liquor Bengal gram (chick pea or *Cicer arietinum*) steep liquor and rice (*Oryza sativa*) steep liquor on the production of penicillin on surface culture, 30
JOHNSON, FRANK H.: Luminescence of biological systems (Review), 313
JOHNSON, M. A.: (Review), 240
JOHNSON JR., TERRY W.: The genus *Achlya*: morphology and taxonomy (Review), 389
Jouvea, 1, 2, 3, 4; *pilosa,* 1, 2, 3; *straminea,* 3
Juglans, 209, 210; *Juglans cinerea,* 209; *nigra,* 209, 383
Juniperus virginiana, 209
KARLING, JOHN S.: Unrecorded hosts and species of *Physoderma,* 292; New and unidentified species of *Synchytrium,* II., 415
KAVANAGH, F.: (Review), 313
KIMBLE, G. H. T.: Geography of the Northlands (Review), 78
Kobresia hyperborea, 192; *hyperborea* var. **alaskana, 192, 194,** 195; *hyperborea* var. *hyperborea,* 192, 194, 195; *hyperborea* var. **lepagei, 192, 194,** 195; *macrocarpa,* 192; *myosuroides,* 129; *schoenoides,* 192, 195; *simpliciuscula,* 194; *simpliciuscula* var. **americana, 192, 194,** 195
Koeleria, 336; *phleoides,* 335; *pyramidata,* 335; *villosa,* 335
Krigia virginica, 385
KUCERA, C. L.: Composition of pre-settlement forests in three counties of Missouri, 207
Lactobacillus, 333; *leichmannii,* 331
LANFRANCO, GUIDO G.: Guide to the flora of Malta (Review), 388
Lathraea clandestina, 168
LEHR, J. HARRY: An annotated preliminary catalogue of the vascular flora of Rockland County, New York, 435
Lemna, 426, 427; *major,* 426; *minor,* 421, 422, 423, 426
Lepidagathis Hamiltoniana, 154
Leptosira, 143
Leptosphaeria acuta, 409; *lemaneae,* 409
Lespedeza hirta, 173; *intermedia,* 173; *virginica,* 173
LEWIS, HARLAN: The genus *Clarkia* (Review), 82
LEWIS, MARGARET ENSIGN: The genus *Clarkia* (Review), 82
Limnodea, 336; *arkansana* 335, 336
Lingusticum grayi, 292; *simulans,* 293
Liparis, 264
Liriodendron, 352; *tulipifera,* 354
Lophira alata-Parkia, 287
LORD, LOIS P.: The morphological and cytological distinctness of *Botrychium minganense* and *B. lunaria* in Michigan, 261
Lotus corniculatus, 295
Loudetia arundinacea, 223; *kagerensis,* 223; *superba,* 227
LÖVE, ASKELL: (Review), 440
Lycopersicon esculentum, 196
Lycopodium, 436; *carolinianum,* 78; *clavatum* var. *megastachyon,* 436; *complanatum* var. *flabelliforme,* 436; *lucidulum,* 436; *obscurum,* 436
Lygodium palmatum, 78
Lysichiton, 151, 152; *camtschatcense,* 151
Lysichitum, 151, 152

Lysimachia quadrifolia, 173
MACHLIS, LEONARD: Plants in action: A laboratory manual of plant physiology (Review), 442
Manilkara multinervis, 283
MARAMOROSCH, KARL: Biological transmission of plant viruses by insect vectors, 234; (Review), 388
MATHEWS', F. SCHUYLER: Field book of American wild flowers (Review), 81
MCCORMICK, JACK: Botanical bibliographies: classification, form, arrangement and use, 377; *Sporobolus cryptandrus* (Torr.) A. Gray in the New Jersey Pine Barrens, 439
Medicago arabica, 294, 295; *denticulata*, 295; *falcata*, 295; *rotata*, 295; *sativa*, 295
Medical research: a mid-century survey (Review), 386
Melampsora, 222; *syntherismae*, 222
Microchloa, 232
Microsynchytrium, 419
Millettia barterii, 222
Mimulus, 265
MITCHELL, HERSCHEL K.: Genetics and metabolism (Review), 81
MONACHINO, JOSEPH: The sarmentogeniferous variety of *Strophanthus sarmentosus*, 281
Morphological and cytological distinctness of *Botrychium minganense* and *B. lunaria* in Michigan, 261
Morus rubra, 209
Muellerella, 403, 407, 408; *haplospora*, 407; *lopadii*, 407; **nigra, 403, 404,** 405, 408; *polyspora* var. *hospitans*, 407; *thallophila*, 407
Muellerella, A new species of and its development, 403
MUENSCHER, W. C.: Garden spice and wild herbs (Review), 82
Muhlenbergia, 232, 336
Myrica pensylvanica, 172
Myriophyllum, 6, 10, 14, 15; *spicatum*, 5, 7, 8, 11, 12, 13, 14, 15, 16; *spicatum* subsp. *exalbescens*, 5, 15; verticillatum, 13, 14, 15
Nasella pubiflora, 231
Nasturtium amphibium, 297
NELSON, ERICH: Gesetzmässigkeiten der Gestaltwandlung im Blütenbereich Ihre Bedeutung für das Problem der Evolution (Review), 238
Neurospora, 46, 427; *crassa*, 39, 59; *sitophila*, 39, 47
NICKELL L. G.: Aseptic studies on metabolism of nitrogenous compounds in plants, 421
Nitrogenous compounds in plants, aseptic studies on the metabolism of, 421
NORSTOG, KNUT J.: The growth of barley embryos on coconut milk media, 27
Notes, 240, 314, 390, 442
Notosciadium pampicola, 294
Nutritive value of *Spartina* grass, 327
Nyssa biflora, 345, 353
Onoclea, 437; *sensibilis*, 437
Ophioglossum, 437; *vulgatum* var. *pseudopodum*, 437
Oplismenus, 229; *compositus*, 223; *undulatifolius*, 223
Orobanche, 168, 169
Oryza sativa, 30
Osmunda, 437; *cinnamomea*, 437; *claytoniana*, 437; *regalis* var. *spectabilis*, 437
Ostrya virginiana, 136, 209
Panicum, 228; *Boscii*, 173; *capillare*, 439; *millegrana*, 228; *olivaceum*, 222; *pectinatum*, 228; *sphaerocarpon*, 222; *virgatum*, 439
Pappophorum mucronulatum, 229; *vaginatum*, 229
Parmelia conspersa, 218, 219; *conspersa-stenophylla*, 218; *isidiata*, 218, 219; *stenophylla*, 218, 219
PATTEN JR., BERNARD C.: Notes on the biology of *Myriophyllum spicatum* L. in a New Jersey lake, 5
Pelargonium, 362
Pellaea, 438; *atropurpurea*, 438
Penicillium, 93, 94, 102, 103, 104; *chrysogenum*, 30, 31, 32, 33, 93, 94, 95, 96, 99, 100, 101, 102, 103, 104; *crustaceum*, 93, 102; *cyclopeum*, 93, 102; *digitatum*, 93, 102; *italicum*, 93, 102; *notatum*, 30, 32, 33, 34, 93, 94, 102, 103, 104; *vermiculatum*, 93, 102
Pennisetum, 224, 229; *typhoideum*, 154
Peperomia, 300, 304; *cilifolia*, 303; **disticha**, 301, **302; falcata, 300,** 301; **namosiana, 302;** *parhamii*, 303, 304; *parhamii* var. **glabra, 304; purpurinodis, 301, 303;** *vitiana*, 304
Perca flavescens, 9
Perotis indica, 230
Phakopsora, 222, 223; *apoda*, 224; *incompleta*, 222; **loudetiae, 223; oplismeni, 223; setariae, 223**
PHINNEY, HARRY K.: (Review), 239
Phleum, 336; *pratense*, 264
Phoradendron florescens, 78
Phragmidiella, 224; **ugandana**, 224
Phyllonoma ruscifolia, 338, 339, 341

Physoderma, 292, 293, 294, 295, 296, 297, 298; *alfalfae*, 294, 295; *claytoniana*, 296; *comari*, 297, 298; *didermoides*, 298; *hemisphaericum*, 297; *hydrocotylidis*, **notosciadii**, **294**, 297, *pluriannulata*, 293, 297; *raysii*, 297; *trifolii*, 295; *vagabunda*, 295, *vagans*, 297
Platanus occidentalis, 209, 383
Pleospora Gaeumannii, 408, 409
Pleurastrum, 142, 146, 147; *paucicellulare*, 142, **143**
Pleurococcus, 142
Poa compressa, 264
Podospora anserina, 47, 58, 59
Polygala, 19, 25, 26; *abyssinica*, 19, 20, 22, 24, 25; *chinensis*, 19, 20, 21, 22, 24; *persicariaefolia*, 19, 20, 21, 22, 23, 24; *triphylla*, 19, 20, 21, 22, 24; var. *glaucescens*, 19
Polygonatum biflorum, 173
Polypodium, 438; *virginianum*, 438
Polyporus cinnabarinus, 136, 137, 138, 139; *sanguineus*, 136, 137, 138, 139
Polystichum, 438; *acrostichoides*, 438
Populus deltoides, 209
Potentilla, 113, 114, 119, 122, 125, 126, 129, 130, 132, 298; *argentea*, 264; *chamissonis*, 113, 116, 117, 119, 121, 124, 125, 126, 131, 132, 134; *crantzii*, 113, 116, 131; *hyparctica*, 113, 114, 116, 119, 120, 124, 126, 130, 131, 132, 133, 134; *nivea*, 113, 114, 116, 131, 132, 134; *palustre* var. *parviflora*, 297; *pulchella*, 113, 114, 132, 134; *rubricaulis*, 113, 114, 125, 131, 132, 133; *uniflora*, 116; *vahliana*, 113, 114, 115, 116, 118, 119, 124, 125, 126, 131, 132, 133, 134
Potentillae of high latitudes and altitudes. II. Central Baffin Island populations, 113
Potzger, John E. (Obituary), 76
Prescott, G. W.: How to know the freshwater algae (Review), 311
Pre-settlement forests in three counties of Missouri, composition of, 207
Proceedings of the club, 307, 386
Protoderma, 143
Prunus, 209
Pseudodendrocloniopsis, 148, 149; botryoides, 142, 143
Pseudodendroclonium, 142; *basiliense* var. *Brandii*, 143
Pseudoplea Gaeumannii, 405, 408, 409
Pseudopleurococcus, 142, 146; *Printzii*, 143
Pteridium, 438; *aquilinum*, 264, 438; *aquilinum* var. *latiusculum*, 173
Pterocarpus lucens, 283
Puccinia, 226; *aegopoponis*, 230; *andropogon-hirti*, 227; *arthurii*, 229; **bewsiae**, 224, **226**; **cissi**, 224, **226**; *cryptandri*, 229; *entrerriana*, 231; *digna*, 231; *erythraeensis*, 227; *eucomi*, 227; *flaccida*, 228; *gymnotrichis*, 229; **hyparrheniae**, 224, **226**; **hyparrheniicola**, **227**, 230; *kawandensis*, 229; *levigata*, 228; *levis*, 228; *loudetiae*, 227; **loudetiae-superbae**, 224, **227**; **millegranae**, 224, **228**; *nasellae*, 231; *negrensis*, 228; **nyasaensis**, 224, **228**; **nyasalandica**, 224, 228; *opipara*, 229; *orientalis*, 228; *pangasinensis*, 228; **pappophori**, **229**, 230; **perotidis**, 224, **229**; *pogonarthriae*, 226; *puttemansii*, 228; **saltensis**, 230, **231**; *simulans*, 229; *taiwaniana*, 228; *tristachyae*, 227
Pyrus, 209
Pythium acanthicum, 196, 198; *anandrum*, 196; *debaryanum*, 196, 204, 205; *mamillatum*, 196, 198, 199, 200, 201, 202; *ultimum*, 196, 198, 204
Quercus, 208, 209, 210, 215, 439; *alba*, 78, 208, 209, 210, 215, 383, 439; *bicolor*, 209, 382, 383, 384; *borealis*, 439; *coccinea*, 439; *falcata*, 209; *heterophylla*, 171, 172; *ilicifolia*, 439; *imbricaria*, 209; *lyrata*, 209; *macrocarpa*, 208, 209, 210, 215; *marilandica*, 78, 208, 209, 211, 215, 439; *nigra*, 209; *palustris*, 78, 209, 383, 439; *phellos*, 78, 171; *prinus*, 78, 439; *rubra*, 78, 171, 209; *Rudkini*, 78; *stellata*, 208, 209, 211, 215, 439; *velutina*, 78, 209, 439
Radiographing surfaces of leaves, 289
Rahn, Joan Elma: A study of the three-dimensional configurations of sporogenous cells in the anthers of *Trillium erectum* L. with special reference to the geometrical aspects of cell shape, 355
Ranunculus, 415, 416; *californicus*, 416; *occidentalis*, 416, 419; *pusillus*, 295, 416
Reeder, John R.: The embryo of *Jouvea pilosa* as further evidence for the foliar nature of the coleoptile, 1
Rhus copallina, 172; *glabra*, 172; *radicans*, 264
Rice, M. A.: Garden spice and wild herbs (Review), 82
Richards, Albert G.: A liquid mold technic for radiographing surfaces of leaves, 289
Ricker, P. L.: (Review), 82
Rickett, H. W.: (Review), 82; Materials for a dictionary of botanical terms—IV. Apices, 342; (Review), 442

Rockland County, New York, An annotated preliminary catalogue of the vascular flora of, 435
Roripa islandica var. *hispira*, 297
Rosa carolina, 172
Ross-Craig, Stella: Drawings of British plants, Part VIII. Rosaceae (1) (Review), 82; Drawings of British plants. Part IX. Rosaceae (2) (Review), 442
Routien, John B.: A new species of *Muellerella* and its development, 403
Roystonea, 306
Rumex acetosella, 196
Sachet, Marie-Hélène: (Review), 80
St. John, Harold: A comment on the generic names of *Lysichiton* and Lysichitum, 151
Salix humilis, 172, 209; *nigra*, 383
Sanicula canadensis, 172, 293; *gregaria*, 172; *marilandica*, 172
Sansevieria, 283
Sarmentogeniferous variety of *Strophanthus sarmentous*, 281
Sassafras, 78; *albidum*, 209
Satureja vulgaris, 264
Saugetia fascicularis, 306
Schatz, Albert: Spectrophotometric studies of *Polyporus cinnabarinus* and *Polyporus sanguineus*, 136
Schatz, Vivian: Spectrophotometric studies of *Polyporus cinnabarinus* and *Polyporus sanguineus*, 136
Schismus arabicus, 336
Selaginella, 436; *apoda*, 436
Seriocarpus asteroides, 173
Setaria aequalis, 224; *lancea*, 224; *sphacelata*, 224
Shaver, Jesse M.: Ferns of Tennessee: with the fern allies excluded (Review), 389
Shoemaker, James S.: Practical horticulture (Review), 173
Sieglingia decumbens, 336
Sinnott, E. W.: A laboratory manual for general botany (Review), 390
Small, John A.: (Review), 389, 390, 442
Smilacina racemosa, 173
Smilax glauca, 172
Snowdenia polystachya, 232
Solidago odora, 173
Sordaria fimicola, 59
Sorghastrum nutans, 173
Sorghum, 190, 433, 434; *australiense*, 190; *leiocladum*, 190; *plumosum*, 190
Spartina, 327, 330, 332, 333, 334; *alterniflora*, 327, 332, 333
Spectrophotometric studies of *Polyporus cinnabarinus* and *Polyporus sanguineus*, 136
Sphenopholis, 336; *filiformis*, 335; *intermedia*, 335; *obtusata*, 335
Spirodela polyrrhize, 427.
Sporobolus, 229, 232; *berteronianus*, 232; *cryptandous*, 439; *fimicola*, 409
Sporobolus cryptandrus A Gray in the New Jersey Pine Barrens, 439
Stauffer, J. F.: Cytological studies on *Penicillium chrysogenum* Thom., 93
Steiner, Erich E.: Studies in Potentillae of high latitudes and altitudes. II. Central Baffin Island populations, 113
Stigeoclonium, 142, 143, 144, 145, 146, 147, 149
Stipa, 231
Stork, Harvey E.: Epiphyllous flowers, 338
Streptochaeta, 1, 2, 4; *spicata*, 1, 3
Striga, 154, 155, 157, 163, 167, 168, 169; *densiflora*, 154; *eupharasioides*, 154, 155, 158, 162, 165, 168; *gesnerioides*, 155; *lutea*, 154; *orobanchoides*, 154, 158, 160, 162, 165, 168
Strophanthus, 284; *amboensis*, 284; *Courmonti*, 284; *Gerrardii*, 284; *hispidus*, 286; *intermedius*, 284; *laurifolius*, 286; *sarmentosus*, 281, 282, 283, 284, 286, 287; *sarmentosus* forma *senegambiae*, 281, var. *major*, 284; var. *sarmentosus*, 281; var. **senegambiae**, 281, 282, 283, 284, 285; *Senengambiae*, 281; var. *sarmentogenifera*, 281, *Welwitchii*, 283
Strophostyles helvola, 173
Synchytrium, 292, 293, 294, 296, 298, 415, 417, 418, 419, 420, *andinum*, 416; *anomalum*, 416; *fulgens*, 420; *ligusticii*, 292; *marginale*, 417, 418, 419; **parksii 416, 417**, 419; *parthenocissi*, 293; *pluriannulatum*, 293; *ranunculi*, 295, 416, 420; **variabilum**, 415, 416, 419
Synchytrium, New and unidentified species, of, II., 415
Tacca involucrata, 283
Tapura capitulifera, 338, 339
Taylor, Norman: Field book of American wild flowers (Review), 81
Teskey, Benjamin J. E.: Practical Horticulture (Review), 173
Tetraspora, 146
Teucrium, 172; *canadense*, 172
Tharp, B.C.: *Commelinantia* (*Commelineae*): An evaluation of its generic status, 107
Thuja occidentalis, 264

TIAGI, B. A.: A contribution to the embryology of *Striga orobanchoides* Benth. and *Striga euphrasioides* Benth., 154
Tilia americana, 209, 210, 215, 383
Tinantia, 107, 108, 110, 111; *fugax*, 111
Three new North American varieties of *Krobesia*, 193
TORREY, JOHN G.: Plants in action: A laboratory manual of plant physiology (Review), 442
Torreya, 72, 171, 234, 305, 382, 435
Tradescantia anomala, 107, 108
Trapa natans, 11
TRELAWNY GILBERT S.: Spectrophotometric studies of *Polyporus cinnabarinus* and *Polyporus sanguineus*, 136
Tribonema, 141
Tricalysia coffeoides, 283
Trichilia, 224
Trichoneura, 232
Trifolium, 415, 417, 418, 419; *carolinianum*, 418; *dichotomum*, 417, 418, 419; *incarnatum*, 295; *involucratum*, 418, 419; *microdon*, 417, 419; *montanum*, 295; *pratense*, 295; *repens*, 295; *resupinatum* 295
Trillium, 361, 362, 363, 370, 374, 375; *erectum*, 355, 356, 358, 374; *sessile*, 410, 411, 412, 413, 414
Trillium sessile: Influences of various buffer salts upon the rate of mitosis in root tips of, 410
Triosteum perfoliatum, 173
Triphragmium (*Puccinia*) *graminicola*, 228
Tripogon, 232
Trisetum, 336; *bifidum*, 335; *canescens*, 335; *cernuum*, 335; *flavescens*, 335; *melicoides*, 335; *spicatum*, 335; *subalpestre*, 335; *wolfii*, 335
Trollius laxus, 385
Tropical rusts, descriptions of,-VIII, 221
Ulmus alata, 209; *americana*, 215, 383; *rubra*, 209
Ulothrix, 141, 142, 143, 144, 146, 147, 148, 149; *bacillaris*, 143, 146, 147, 148; *flaccida*, 148; *subtilis*, 147, 148; *subtilissima*, 147; *tenerrima*, 147
Uniola, 3, 4
Uredo oplismeni, 223
Uromyces aegopogonis, 232; *dactyloctenii*, 232; *fuegianus*, 231; *ignobilis*, *kenyensis*, 232; *leptodermus*, 232; *microchloae*, 232; *minimus*, 232; *pencanus*, 231; snowdeniae, 230, 231; *sporoboli*, 231; sporoboloides, 230, 232; *tenuicutis*, 232; *trichoneurae*, 232; *wellingtonica*, 232
Uronema, 147
Urophlyctis, 293; *notosciadii*, 294; *pluriannulatus*, 293
Uropyxis, 233; *wiehei*, 230, 232
Ustilago Hordei, 58, 59
VENKATESH, C. S.: The special mode of dehiscence of anthers of *Polygala* and its significance in autogamy, 19
Veratrum, 264
Vibernum acerfolium, 78; *dentatum*, 78; *prunifolium*, 78
Viola, 354; *odorata*, 345
WAGNER, ROBERT P.: Genetics and metabolism (Review), 81
WAGNER, JR., WARREN H.: The morphological and cytological distinctness of *Botrychium mingánense* and *B. lunaria* in Michigan, 261
WARD, W. T.: (Review), 312
WARDLAW, C. W.: Embryogenesis in plants (Review), 239
Weeds of North Central States (Review), 311
WELLS, HARRINGTON: General biology (Review), 312
WELLS, PATRICK: General biology (Review), 312
WHERRY T.: The genus *Phlox* (Review), 237
WHITAKER, THOMAS W.: *Cucurbita mixta*, Pang. Its classification and relationship, 253
WILSON, K. S.: A laboratory manual for general botany (Review), 390
WITKUS, E. R.: The cytology of *Xanthisma texanum* D. C. IV. Megasporogenesis and embryo sac formation, pollen mitosis and embryo formation, 428
Woodsia, 437; *obtusa*, 437
Woodwardia, 438; *areolata*, 438; *virginica*, 438
WYLIE, A. P.: Chromosome atlas of flowering plants (Review), 440
Xanthisma, 433; *texanum*, 308, 428, 429, 431, 434
Xanthisma texanum, The cytology of. IV. Megasporogenesis and embryo sac formation, pollen mitosis and embryo formation, 428
Xenodochus, 224
Ximenia americana, 283
YUNCKER, T. G.: Additions to the Fijian species of Peperomia, 300
Zea mays, 30
Zoospores from germinating oospores of *Pythium mamillatum* Meurs, 196

MEMOIRS OF THE TORREY BOTANICAL CLUB

Volume 20 Number 4

CHROMOSOME STUDIES on CALIFORNIA MOSSES

William C. Steere, Lewis E. Anderson and Virginia S. Bryan

Price $2.00

This issue, the final number of Volume 20 of the MEMOIRS, is now available.

The other numbers of Volume 20 are as follows:

Vol. 20, No. 1—Middleton, John T.—The taxonomy, host range and geographic distribution of the genus *Pythium*. 1943. $2.00

Vol. 20, No. 2—Lowry, Robert J.—A cytotaxonomic study of the genus *Mnium*. 1948. $1.50

Vol. 20, No. 3—Stout, Arlow B.—Reproduction in *Petunia*. 1952. $3.50

Dr. Regina M. Duffy
New Jersey State Teachers College
Jersey City 5, New Jersey

The INDEX TO THE BULLETIN OF THE TORREY BOTANICAL CLUB VOLUMES 1–75

(1870-1948)

compiled by Harold William Rickett
published in July 1955

It includes an alphabetical list of contributors, titles of their publications, and subject index.

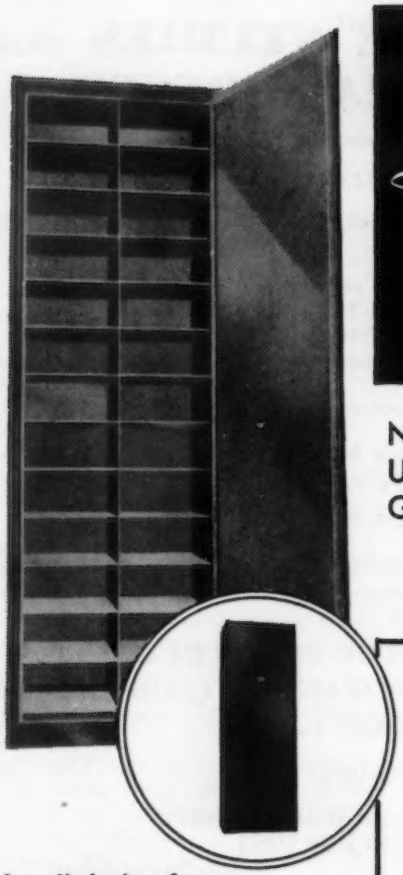
The Bulletin of the Torrey Botanical Club is the oldest botanical journal in the United States. An INDEX to its first SEVENTY-FIVE VOLUMES which covered a period of great growth in botanical science should prove a valuable tool for the researcher and teacher.

Special type indicates new names and combinations and distinguishes place of casual mention and listings in synonymy.

PRICE $15.00

Regina M. Duffy, Business Manager
The Torrey Botanical Club
New Jersey State Teachers College
Jersey City 5, New Jersey

MAXIMUM STORAGE



Lane Herbarium Case
The Accepted Standard for general use

Lane HERBARIUM CASES

NOW IN USE IN OVER 115 UNIVERSITIES, BOTANICAL GARDENS, NATIONAL PARKS, ETC. since their introduction!

SPECIFICATIONS

STANDARD HERBARIUM
84 1/8" High, 27-13/16" Wide, 18-25/32" Deep

JUNIOR MODEL HERBARIUM
40" High, 27-13/16" Wide, 18-25/32" Deep

SOME USERS OF LANE HERBARIUM CASES

New York Botanical Gardens
Abilene Christian College
Agricultural & Mechanical College of Texas
Duquesne University
Florida State University
Georgia Teachers College
Louisiana Polytechnic Institute
Loyola University
Oklahoma Agricultural & Mechanical College
Southern Methodist University
State College of Washington
Tulane University
University of Alabama
University of Arizona
University of Arkansas
University of Chattanooga
University of Massachusetts
University of Idaho
University of Nevada
University of Texas
University of Wisconsin
Washington University
Yale University
Grand Canyon National Park
Olympic National Park
Hawaii National Park
Glacier National Park
Canisius College
Catholic University of Washington
Carleton College
Emory University
U. S. Dept. of Agriculture
Oregon State College
Riverside Municipal Museum
Rutgers University

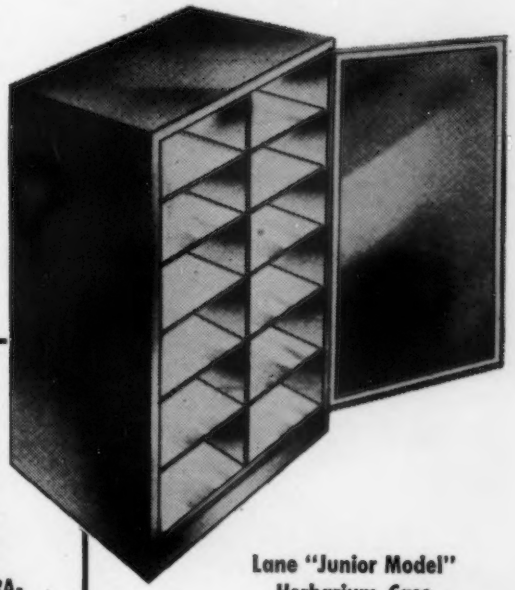
PROTECTION

JUNIOR MODEL HERBARIUM CASE

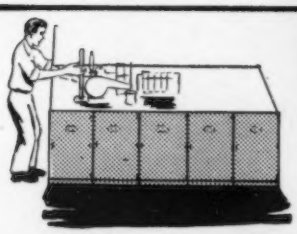
CHECK THESE OUTSTANDING FEATURES:

- Air-Tight and Insect Proof Seal
- Standard Size Compartments
- Three-Point Compression Type Locking Mechanism
- Effective Air Circulation and Fumigation
- Right or Left Doors
- Double-Wall All-Steel Construction

IDEAL FOR SUPPLEMENTAL USE, WORK TABLE, UNDER WINDOWS, SMALL COLLECTIONS, STUDENTS, ETC.



Lane "Junior Model" Herbarium Case



A WORK TABLE IN THE LABORATORY WITH LINOLEUM COVERED WORKING TOP.

ALL LANE HERBARIUM CASES ARE DELIVERED COMPLETELY ASSEMBLED AND READY FOR USE.

WRITE FOR COMPLETE DETAILS.

Institutional Division CHAS J Lane CORP

105 CHAMBERS STREET, NEW YORK 7, N. Y.

Instructions for Contributors

Contributions will be received only from members of the Torrey Botanical Club.

Manuscript should be typed double-spaced on one side of standard paper. If a line of 60 characters is used and 26 lines to the page, the number of printed pages (exclusive of illustrations and bibliography) will be about half the number of typed pages. The editor may accept papers up to 16 printed pages in length. Preference will be given to shorter papers. Illustrations (including tables and graphs) should not exceed 20 per cent of the text; the authors of more copiously illustrated articles may be asked to pay for the excess.

Drawings and photographs should be mounted on stiff cardboard and the desired reduction plainly indicated. Figures should be so planned that after reduction they will occupy the entire width of a page (4⅝ inches) and any portion of the height (7⅛ inches). Labels should be parallel to the shorter dimension of the page. It is best to combine illustrations into the smallest possible number of groups. The editor cannot accept loose figures or figures so mounted as to leave large unused spaces on the printed page. The thickness of lines and dots must be planned with the desired reduction in mind; it is still more important to calculate the requisite spaces between lines and dots.

Figures should be numbered consecutively. Plates are not inserted unless special methods necessitate them. Legends for figures should be typewritten and included with the manuscript (*not* affixed to the figures). All legends for one group of figures should form a single paragraph. If magnifications are stated, they should apply to the reduced figures.

In style recent usage of the Bulletin should be followed. This applies to punctuation, capitalization, use of italic, designation of new species and combinations, citation of specimens and synonyms, and reference to literature and illustrations. References to literature are made by date. Time and errors will be saved if the usage and abbreviations of the Index to American Botanical Literature are adopted. The title of the paper should be as short as is consistent with clarity. Primary divisions may be indicated by centered headings, subdivisions by italicized captions at the margin. Except brief notes, every paper should conclude with a summary of numbered paragraphs. The institutional or other address of the author should appear beneath the summary.

Contributors may order reprints of their articles when they return galley-proof to the editor. A schedule of charges is sent with the proof, and will be supplied to prospective contributors on request.

FINE MICROSCOPE SLIDES FOR DISCRIMINATING BIOLOGISTS

TRIARCH SLIDES stress beauty as well as utility, and their freedom from artifacts aids student comprehension.

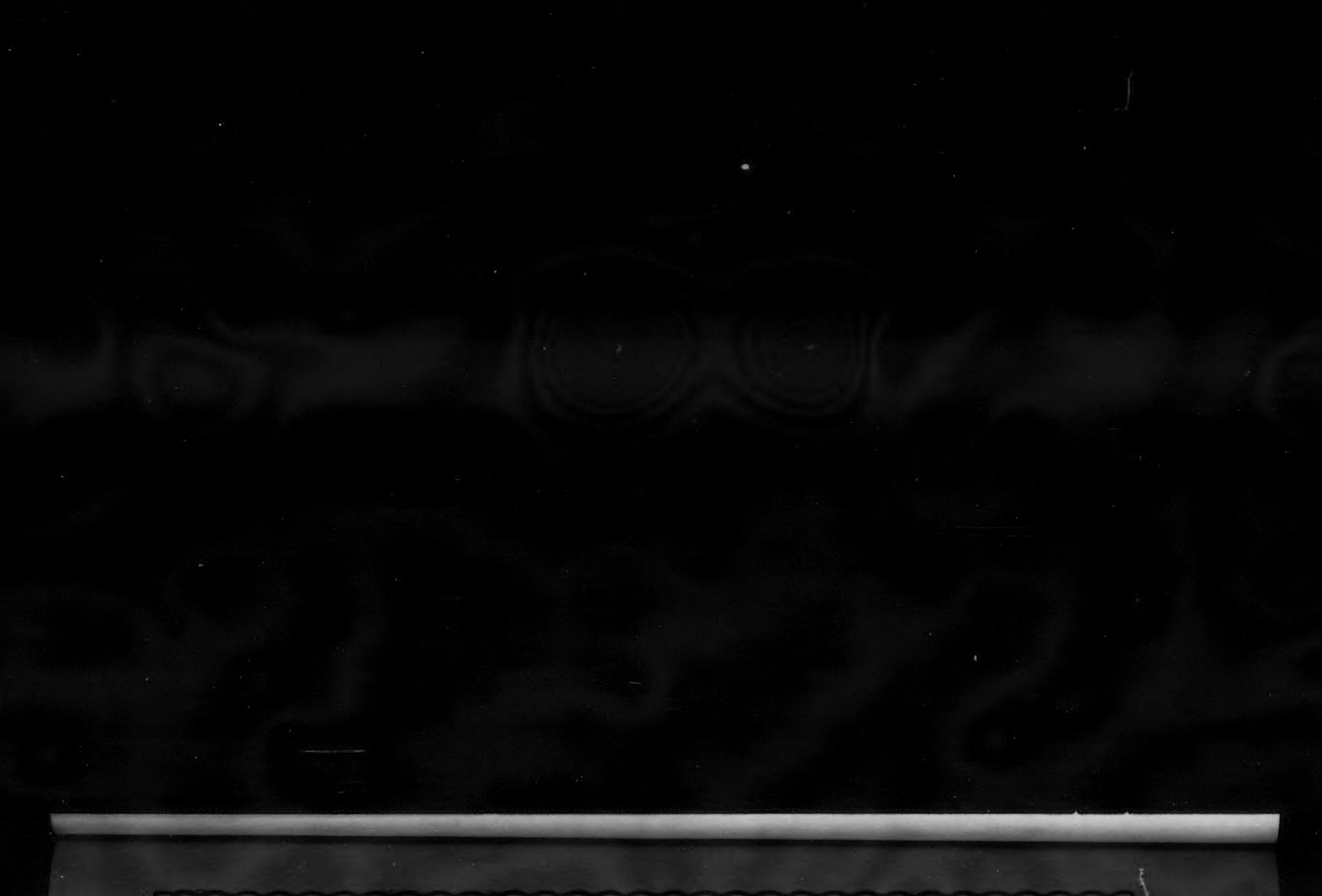
GOOD SLIDES cannot be produced cheaply, yet TRIARCH slides are moderately priced, and the catalog price includes all delivery costs to any address in the United States.

TRIARCH gives you accuracy and dependability, with rapid service.

TRIARCH CATALOG NO. 10, with many new full-page photomicrographs, is now being distributed. Both plant and animal slides are listed.

For Catalogs, write to:

TRIARCH PRODUCTS

GEO. H. CONANT

RIPON, WISCONSIN